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Engineering News-Record

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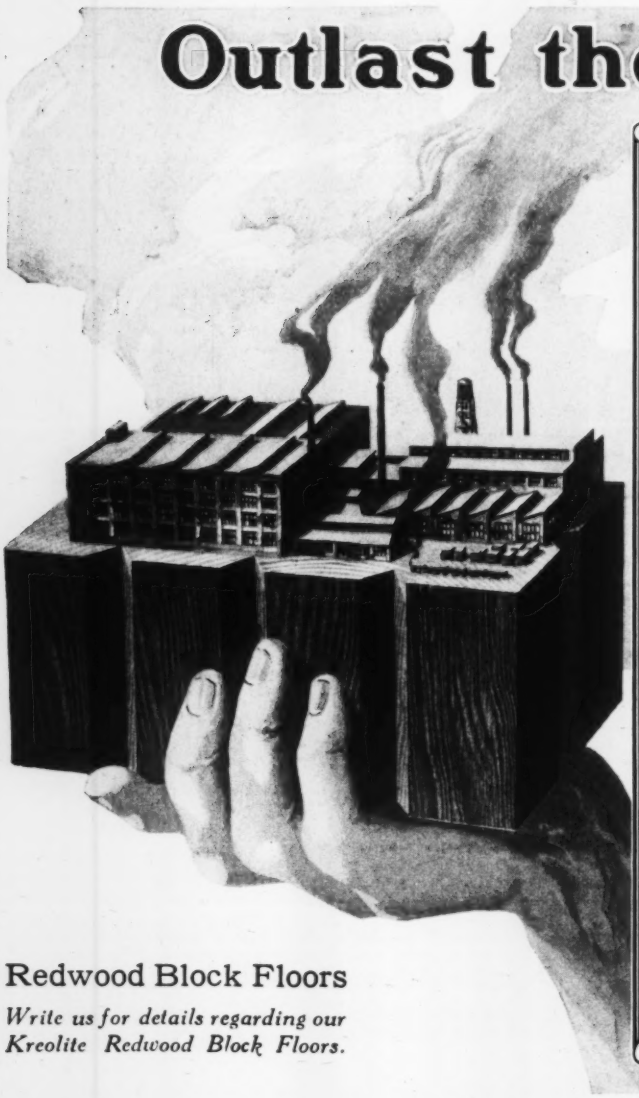

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

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Publicity That Doesn't Take

WHATEVER other tricks the engineer may have taken from the kit-bag of the "successful business man" he seems to be in the dark still as to the essentials of sure-fire publicity. Literature circulated by professional societies is always welcomed by this journal, for it offers an excellent opportunity to brief activities the country over. One detail of such publicity, however, is more or less necessary to make these items intelligible—the name of the society. This short note is inspired by the receipt of a program which some society invites us to attend. Yet the sole directions on the invitation card where one may enjoy this program are: "Come over to the Clubhouse." The officers' names and the street number of the club are given. Our guess as to the identity of the club would probably be correct. But guessing has no place in good journalistic practice.

Scenic Boulevards

ROADS built to attract the tourist who is out to see scenery are being put on high elevations wherever possible. No road on the plain, other things being equal, can afford the same thrill and exhilaration that attends a ride over a road built on a high, commanding location. The psychologist might say that this reflects a harking back to the primitive when safety depended upon keeping a sharp lookout, while the matter-of-fact scientist would probably say that it is because the range of vision is greater at high elevation. Be that as it may, it is notable that the skyline boulevard now being built from San Francisco south follows the very ridge of the range of hills it traverses, and so does the "ridge route" on the grade at the lower end of the San Joaquin Valley and the Mulholland Boulevard just completed in southern California. The short stretch of the Columbia Highway in Oregon that overshadows all the rest of that route in point of attraction is located on a high commanding cliff. In the East, too, particularly along both banks of the Hudson and on certain stretches of the Connecticut, this combination of river and hills has been effectively utilized. Road location must depend upon many things beside scenic advantages, but where there is an alternative present day practice shows strong preference for the higher elevation.

Railroad Securities Come Back

AFTER a period of over ten years, in which there has scarcely been an offering of railroad stock, several roads have put out stock which was immediately oversubscribed. This is a significant fact. Ordinary expansion of railroad facilities even in these days of little new construction calls for an enormous amount of new capital.. To raise all this by means of bond issues, as has been necessary during the past few years, has put many railroads in a precarious condition financially, and cannot be continued indefinitely. To be able to raise this money through the issue of stock, the excess of railroaod income over expenditures must be sufficient to pay an attractive return on capital stock. The lack of such adequate net income was responsible for the condition of railroad finances during the past few years and it appeared for a time as if the railroads would go down to financial ruin. But the railroad companies have saved the day by a program of increased efficiency which has resulted in the breaking of record after record for car loading, car-miles and engine-miles. Still the railroads are not all out of the woods financially, by any means. Most of them will need to resort to bond issues to obtain new capital and many may yet need an increase in rates. But whatever the future may hold for them in the pending discussion of rates the railroads can now go before the country with a splendid record of increased efficiency. They are to be congratulated on what they have done.

Bypass Highways

WITH the increase of throuh traffic on highways, towns and cities are beginning to reconsider their desire to have the main road pass through the main street. In the larger communities the congestion of their own street traffic is helping along the change of belief. Even in the small towns, however, the citizens are coming to understand that the through traveler who wants to get on brings nothing but extra wear and congestion while the through traveler who wishes or needs to tarry for food or other accommodations will do so if he is provided a reasonably convenient detour from the main road to main street. Indeed there is everywhere encouraging indication that the state road engineer's problem of by-passing towns on his through roads is being made more simple by more correct thinking by village and town dwellers. There is obviously a long way to travel before everywhere the by-pass road can be considered solely as a problem in highway engineering and highway transport but we may begin to feel that at least that way is becoming more open. The articles on by-pass roads, in this and preceding issues, indicate the results. They also present some of the problems. It is very clear that the by-pass road is not a universal benefit to through travel any more than traversing main street is universally a local advantage. Indeed these articles make it clear that the adoption and location of by-pass highways in every instance calls for rather cunning engineering-economic reasoning.

Radio in Camp

RADIO receiving equipment in the recreation hall of the construction camp has supplied an urgent need that could not possibly be filled by anything heretofore available. After all, building a construction camp is

nothing more nor less than making provision for the needs and comfort of workmen. It is as important to keep the men contented and satisfied as it is to feed them well. Recognizing this fact, the recreation hall is now rated as a necessity for several reasons. It helps to keep down the labor turnover and thus keeps the cost down. The average workman, too, is much better off if he can find satisfactory entertainment when off duty right on the job. From the contractor's point of view, in such emergencies as a fire or a break of some kind it has been of immeasurable value to have the men readily available. At first papers and magazines and perhaps books were enough "equipment" for the recreation hall. Pool and billiards followed and did much not to be accomplished by reading matter. These pastimes, however, were too tame on the occasion of any particular interesting athletic contest, especially a baseball or football game or a prize fight or when election returns were coming in, and at such times groups of men often leave camp and go to the nearest place where they can get the results promptly. It is not so much that the news concerns them particularly but rather that they want to experience the excitement in the crowd as well as the group reaction to the outcome. Radio has made it possible to satisfy this craving right in camp and for that reason, if no other, is a necessary part now of camp equipment.

A Sensational Report

QUESTIONS of safe engineering design are brought to the front in strikingly interesting form by the long-awaited finding in the Boston molasses-tank case. The auditor's report, briefly reviewed in this issue, is decidedly sensational. He finds that there is no evidence to support the bomb-explosion theory advanced by the defence, and holds that the tank failed because it was too weak: "The high primary stresses, the low factor of safety, and the secondary stresses, in combination" brought about its failure. But the most sensational part of the report is the auditor's reference to the hopeless contradiction of two sets of engineers. The reference is politely phrased, but is none the less caustic. He takes comfort in the fact that "at least half the scientists must be wrong," not a very flattering verdict to pass on engineers testifying on a definite question of public safety. He lays a gentle indictment against the sincerity of the engineers who swore that the ill-fated tank was safe but also said that they would have designed it differently. The indictment may seem unfair, for every engineer realizes that a structure may contain features which he would not endorse as good practice but which he is not prepared to denounce as unsafe. And in this particular case the experts for the defence could rest their opinion on the fact that the tank had been in use for three years without giving rise to alarm. But the auditor had before him evidence which showed that the direct tension in the tank shell exceeded 30,000 lb. per square inch at the joints, and in addition had the unanimous testimony of all of the engineers to the effect that secondary stresses at the lap joints and elsewhere would still further increase the tax upon the metal. This largely explains the indictment: the auditor evidently felt that the facts were so serious as to call for an unequivocal defence of the design or else an equally unequivocal admission that it was dangerous. The unfortunate outcome of the matter is that he expresses open disbelief in the worth of engineering expert testimony. It is regrettable that the engineering expert should thus in effect be ranked with the criminological alienist; those who think of engineering as an art based on exact knowledge and on unprejudiced estimate of physical fact will therefore not find the report particularly pleasant reading. At the same time they are bound to give the auditor their appreciation for the sanity and directness of his conclusions.

Preventing Structural Failures

AT THE VERY heart of the molasses-tank case lies the fact that the tank was ordered and built without the assistance of competent technical men. It was bought on a layman's notion that "a factor of safety of three" met all demands of safety. Neither design nor execution was checked. Public building inspection failed—as it has in other cases—to provide the missing element of competent engineering. The responsibility of the owner, which has often been claimed to be the best protection against bad building, amounted to nothing in the way of protection, even though the owner was a large corporation. In fact its responsible official did not have the finished tank tested "in part because there was not time, in part because it would be too expensive to buy the water, and in part because he did not think it was necessary"—a neat combination of self-sufficient wisdom and Yankee thrift. The one indispensable element of safety in the construction of engineering structures, having a competent engineer direct the design and execution so that he can certify to the safety of the finished structure, was absent in this case as in prior structural accidents. There is a simple way to assure its presence: to require that engineering structures may not be built except on a competent engineer's design and under his supervision, and may not be put into service except on his certification of safety. This is, in fact, the building-reform recommendation that was made last spring by a joint committee of architects and engineers which investigated the causes of structural accidents. If any steps have been taken to carry this recommendation into effect by legislation, we have not heard of them. It should be done, if only in order to give a practical demonstration of what the proposed method will accomplish. So long as incompetent persons are left free to build, with no safeuard other than *pro forma* municipal granting of a permit and nominal inspection, we may expect to have other molasses-tank failures in the future.

Higher Stresses for Steel

PROGRESSIVISM almost to the point of radicalism is displayed in the recommendations of a committee which reported to the American Society of Civil Engineers last week that working stresses for structural steel should be raised from the present 16,000-lb. to a 20,000-lb. basis. The report, if it is radical, is such not because of the 20,000 lb. but because it pays little heed to precedent, in spite of the large part played by precedent in most engineering conclusions. The committee proceeded not by stepping up from the present stress but by drawing its conclusions as to safe stress from the results of experience with structures in service.

Precedent received fuller recognition in the dissent-

ing opinion of a minority, which, while agreeing with the majority that present stresses are too low, was not willing to go more than a short, cautious step beyond current practice. It will be interesting to learn what views on the two sides of the question develop in the full discussion; the limited discussion at the meeting was strongly favorable to the 20,000 recommendation, but it is known that the conservative side also has its adherents. Moreover, there are engineers who believe that, while they themselves could be trusted to design on a 20,000-lb. basis, others could not—a curious view when considered from the professional standpoint.

A noteworthy feature of the committee's report is the reiterated statement that its recommendation depends on proper load and stress calculation and upon competent design and construction; the assertion is made that improper designing, defective material and poor shop or field workmanship can not be made safe by imposing low working stresses. This point bears very intimately on the entire subject of the report. At present there is such widespread belief that the 16,000-lb.-base stress is needlessly and wastefully low that various practices not strictly in accord with good design principles are resorted to as a means of economizing material. As a result some parts of the design of steel framework are even now being carried out on a basis of 18,000 lb. and even more, and this has been true for some time past. Such practice is not chargeable to any inherent sinfulness of engineers, but to the human tendencies which make a dead letter of any obsolete law.

Probably there are some engineers who would prefer to see the old 16,000-lb. rule continue indefinitely and are willing to have it flaunted, or even to flaunt it themselves. But this process is more likely to debase engineering practice than to do any good. Placing working stresses on a proper modern basis, conforming demands of efficiency, is in the direction of progress.

Financial Soundness in Reclamation

FOR some time past it has been well understood that political agitation is the fundamental evil of federal reclamation work. A more important fact has been less clearly perceived, however, namely that the greatest harm is done less by political meddling *per se* than by the effects of the unsound financial principles which are thereby allowed to come into play. Reclamation will cease to be a source of bitterness and contention only when it comes to be founded permanently on financial methods as sound as those in private dealings.

Facts brought out by the experiences of last season, when greatly improved crop and price conditions favored the reclamation projects, throw new light on the urgent need for applying sound financial control, even if strenuous methods must be applied. In spite of the improvement in agricultural conditions, some of the best projects showed an increase in unpaid debts. The farmers were much better able to pay than in the preceding year, but they actually paid the government less, in spite of having had the help of relief bills which for several years in succession enabled them to put off their overdue payments. These circumstances clear up what has remained a doubtful point: the reclamation farmers have often been accused of deliberate unwillingness to pay their contractual debts to the government, but their vehement denial has cast doubt on the truth of the accusation. The present facts plainly convict them of the charge.

The farmers have found it easy heretofore to bring about the passage of debt postponement laws regularly at each session of Congress that many of them, at least, have come to regard their debts as political rather than financial. It is surprising how widespread among them is the sentiment that it is the nation's natural obligation to build costly works to water their farms, and that they should not be compelled to pay the cost of these works but should, as first settlers, be entitled to pocket this investment by selling their farms at high prices. More than once this sentiment has been encouraged or even stirred up by electioneering features of congressmen or senators, directly inviting the farmers not to pay and promising them that the government would ultimately cancel the obligation.

At the root of the evil, unquestionably, is the unsound plan of interest-free loans. This plan was laid down by the original Reclamation Act, nearly a quarter century ago, when it could not be foreseen just how the work would develop and a broadly idealistic view was taken of the Western situation. In spite of the many instructive experiences that followed the act, however, the interest-free provision was never changed. And it is obviously easy to think of throwing off interest when government funds are concerned. Only recently, for example, interest-free loans of government money were made to certain Southern river cities for the construction of shipping docks, the loans to be repaid on an installment basis which in effect makes the city a gift of half the investment. Thus, it is easier to understand that Senator Newlands' original legislation for irrigation development should have been based on an unsound plan of financing. Farming is a business that cannot possibly be sound unless it is able to pay its way; that should be evident. It is equally clear that farming cannot be sound if certain groups of farmers are subsidized by remission of interest, to the disadvantage of all other farmers. The unsoundness of the condition becomes still worse if, in addition, the payment of current operating costs and of installments of principal is year after year deferred by new laws, and the unpaid amount added to the principal, in the best fashion of usury, perhaps to be repaid ultimately by the children or grandchildren of the original debtor.

Blanket debt postponement legislation, then, is fatally unsound, and increases all the harmful effects of the unsoundness of the original interest-free loan plan. Fortunately, there are signs that both the reclamation officials and the responsible leaders of reclamation activity in Congress are becoming aware of this fact. When the fact is fully established as an official conviction, and federal reclamation is wholly based on sound and businesslike methods of financial control, we may look to see the present unsatisfactory conditions of the existing and of future projects definitely reformed.

Moratoriums, interest-free funds, and blanket relief legislation are the outstanding elements of financial unsoundness in federal reclamation. That they would be ruinously unsound in private business dealings is obvious; how they can be any less ruinous and wrong in a federal enterprise has never been shown. They are easy to correct, providing only the members of Congress abandon the idea of making pork out of reclamation by diverting federal funds to their own constituencies.

Sand Dams Built by Hydraulic Fill in Northern New York

Hydraulic Development on Beaver River Near Watertown Calls for 860,000 Cu.yd. of Sand Fill in Two Dams—All Material Sluiced in Closed Pipes

TWO PURE SAND dams built as hydraulic fills are outstanding features of a small hydro-electric power development on the Beaver River in northern New York. The Beaver River is a branch of the Black River, and the new plant is one of a number which bead the lower stretches of those two streams. Its present installation will be two 10,000-hp. wheels, with an emplacement in the power house for a third wheel when conditions appear right for its installation. The plant will be an important unit in the group of plants which constitute the development of the Northern New York Utilities, Inc., of which W. P. Creager is vice-president and chief engineer.

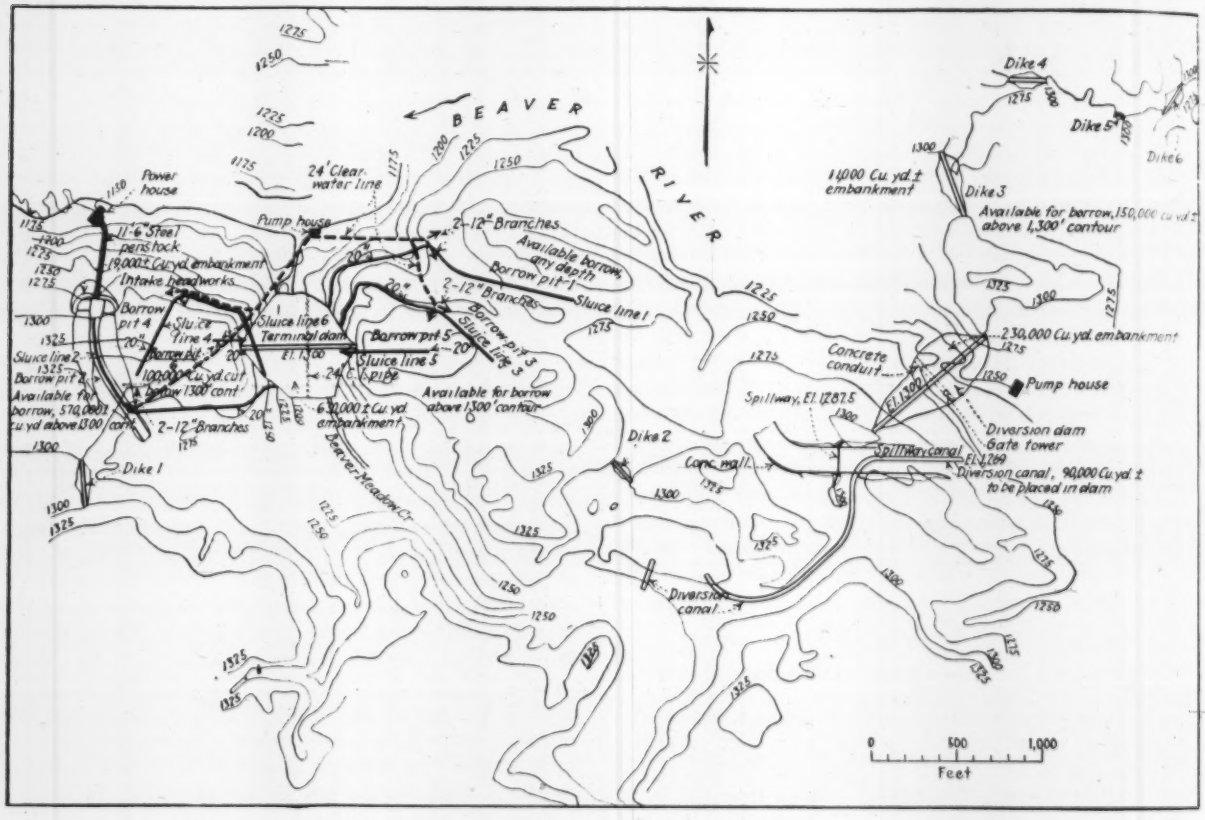


FIG. 1—TOPOGRAPHIC LOCATION OF BEAVER RIVER HYDRAULIC DEVELOPMENT

Chief interest lies in the construction of the hydraulic-fill sand dams. The material is truly sand, the content of particles over ¼ in. being practically negligible. Analysis, however, shows plenty of fine material for core. This fine material is also sand, crystalline silica as shown under the microscope. There is virtually no clay. It is sand so fine that its separation is possible only by elutriation. There is enough of this fine material in the natural sand, it was found, to provide ample core in the fill. Here, however, it is the construction problem that will be discussed.

Controlling Conditions—In the territory of the development operations, the topography is rather a jumble of sand hills through which the stream winds. The condition is fairly typified by the developed contours of the territory embraced by the power plant structures as shown by Fig. 1. The hills shown are sand, under a few feet of top soil, to rock, generally very deep down, as indicated by the profile of the terminal dam, Fig. 2. Some of the views show the surface and subsoil characteristics plainly. It is to be noted particularly that the sand is loose and a bank slips down like sugar when dug into and dried out. Breaking down, either by shovel or water, is no task in excavation.

The plant structures are shown on Fig. 1. Noting the course of the Beaver River, the first structure is the diversion dam between the flanks of two sand hills. Around the south end of the dam swings the spillway channel. Beginning in this channel is a diversion canal in two parts separated by a little bowl between hills. The diversion canal leads into the valley of Beaver Meadow Creek at the lower end of which, between two sand hills, is the terminal dam, with the intake channel, headworks, penstocks and power house lying to the west. Six earth dikes, clearly indicated, close off small draws leading out of the diversion and terminal ponds. These two ponds are the hydraulic feature of the development.

Construction, excepting the penstock and power house and, in the diversion dam, a conduit and corewall, was a task of excavation and fill. Two main fills were to be

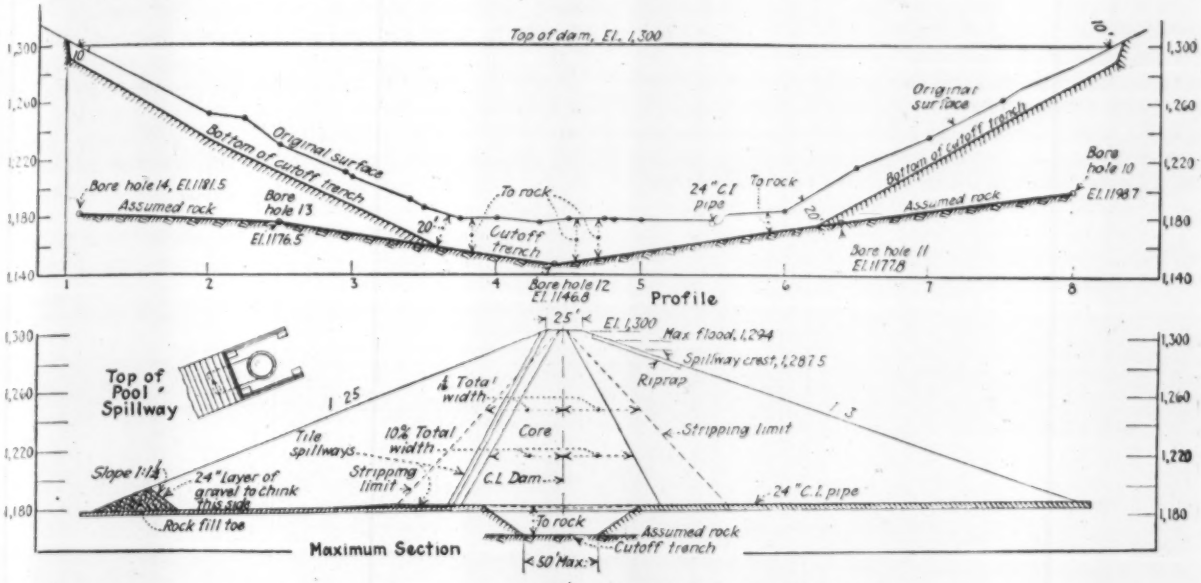


FIG. 2—SECTION OF LARGE HYDRAULIC-FILL SAND DAM

made between sand hills and two channels were to be excavated through sand hills flanking the fills. Excavation from the channels and other materials borrowed from the tops of the sand hills were to make the fills. Fig. 1 indicates clearly the respective yardages in dams and channels and available in the various borrow pits. It was contemplated that construction should be by hydraulic fill or modified hydraulic fill, and straight hydraulic fill was chosen by the contractors.

Developing Operations—The dam location is about 40 miles from Watertown, N. Y., which is headquarters for the Northern New York Utilities, Inc. Croghan, a little village terminal of the Lowville & Beaver River R.R., is ten miles away and is the nearest railway station. From Croghan toward the plant there was a country road for about eight miles, with the last two miles little more than a trail. From this country road two miles of new road had to be built through woods to the dam site. Access then is by rail to Croghan and by road from Croghan to the dam—all materials and equipment take this journey. The bearing of this condition on methods of dam construction is important.

Any method, except the hydraulic, of making the fills and cutting the channels would require many units of heavy equipment—power excavators, locomotives, cars and rail, all difficult of transport in comparison with pumps and motors and lengths of pipe. These have come in handily by truck or tractor. In contrast the two steam shovels and one large dragline excavator employed on the work had to crawl in, about a mile a day, under their own power. As a plant transportation task, then, hydraulicking plant had everything in its favor. It could be brought in and taken out again with a fraction of the trouble that would be necessary in handling any other equipment for earth dam building.

With access by road effected, camp construction for 375 men, and clearing dam sites, excavation and fill followed in succession as the equipment came in. Plant arrangement on these different operations is the noteworthy thing.

Equipment Allocation—Fig. 1 shows the main structures: (1) A diversion dam with its appurtenances of spillway and diversion canal, (2) a terminal dam and (3) a power house with intake channel, headworks and penstocks.

All structures are indicated by Fig. 1. Fig. 2 is a section of the terminal dam. The diversion dam has a crest length of about 1,000 ft. with a 25-ft. top width and a greatest depth of 80 ft. The upstream slope is 1 on 3 and the downstream 1 on 2½. There is a con-

FIG. 3—GIANT STARTING BORROW PIT, PRESSURE AND SLUICE LINES SHOWING

crete corewall to El. 1,267 (flood elevation being 1,294 and the crest of the dam 1,300). This wall is 2 ft. wide on top with a batter of 18 on 1, giving it a thickness at the deepest point of 5 ft. 9 in. All flood control is at the diversion dam by means of a gate tower and a 12-ft. circular conduit through the dam and, of course, the spillway channel.

As located the power house is founded on rock excavated within a crib cofferdam. About 2,000 cu.yd. of excavation and 4,000 cu.yd. of concrete are the main construction items. The penstocks are two 14-ft. steel pipes about 475 ft. long, buried 3 ft. deep in trench and having their upper 70 ft. encased in concrete. They terminate at their upper ends in a concrete headworks.

It has been noted that the structures are in two

groups separated some distance. The construction operations are: (1) Primarily hydraulic fill and borrow pit excavation by water; (2) emplacement excavation, as stripping for the dams, cutting core trenches, quarrying foundations for the power house, and (3) concrete construction. As each kind of work existed at both groups of structures two outfits were necessary. Construction was started by the general contractor with the intention of building both dams himself. Later he decided to sub-contract the diversion dam work. The consequence was in a great measure independent selection of outfits but with an intercontract power service and use of other facilities and a measure of harmonious plant planning. The two groups of operations may therefore be considered together.

Emplacement Excavation—Stripping and core trench excavation for the dams were dragline excavator operations, although some of the trench on the slopes was hydraulicked. The plant comprised a 1-cu.yd. and a 2-cu.yd. dragline excavator and a 4-in. dredge pump with hose, nozzles and sluice pipe. The 2-cu.yd. dragline was used also for intake canal and penstock excavation. This was all electrically operated equipment.

Rock excavation for the power house foundation and on the diversion dam and elsewhere was straightforward drilling and blasting using hammer drills, derricks and on the diversion dam industrial track and gas locomotives. A separate compressor was installed for each operation; they were electrically operated. Except for two derricks on the diversion dam all derricks had electric power. These were principally an 86-ft. boom machine on the power house and a 70-ft. boom derrick on the intake.

Concrete Construction—For the power house and the penstock head wall about 7,000 cu.yd. of concrete was mixed at a plant alongside the power house site. The plant consisted of a 1-cu.yd. mixer, the derricks, before mentioned, at power house and intake, four ½-cu.yd. bottom-dump steel buckets and an incline railway, with electric hoist, from mixer to intake. All machines are motor operated. At the dam the concrete plant is two ½-cu.yd. gas engine mixers and one ¾-cu.yd. electric mixer, derricks and an industrial railway. Aside from the largely electric operation of plant and, in the power house, the usual complex formwork for turbine emplacements, there were no extraordinary features in any of the concrete construction.

Hydraulic Fill—Hydraulic excavation and fill are the outstanding operations. They are indicated, on Fig. 1, quite fully for the larger terminal dam well under way. Only certain plant features of the diversion dam work can be indicated, as actual sluicing has so far been undertaken only for small fills.

On the map, Fig. 1, the full lines show the location of sluice lines from the several borrow pits to the terminal dam. The dotted lines show the clear water pressure lines from the pump house to the hydraulic

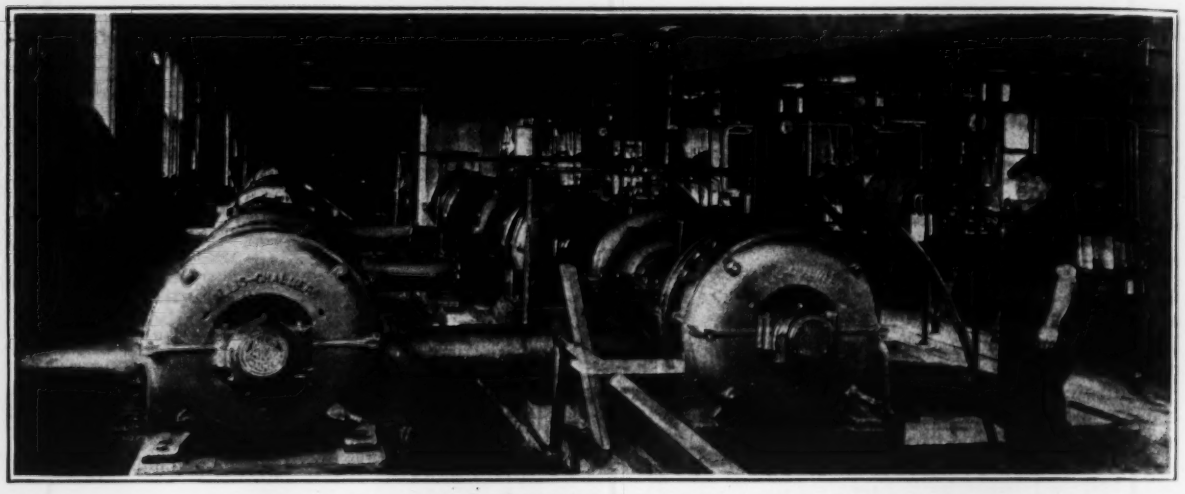


FIG. 4—PUMP HOUSE INTERIOR SHOWING TANDEM PUMP UNITS

giant connections in the borrow pits. The clear water line is 24-in. flange steel or wood-stave pipe, about 1,200 ft. of one and 2,800 ft. of the other. The sluice pipe, 4,000 ft., is all 20-in. high-carbon, manganese steel, slip-joint pipe.

The pumping plant located on the river bank below the dam has six 3,400-g.p.m. suction pumps, and six 3,400-g.p.m. booster pumps. Each pump is operated by a 200-hp. motor, the arrangement being shown by the interior view of the pump house, Fig. 4. A feature of the pumping plant is the valve arrangement for grouping pump delivery. As indicated by the sketch,

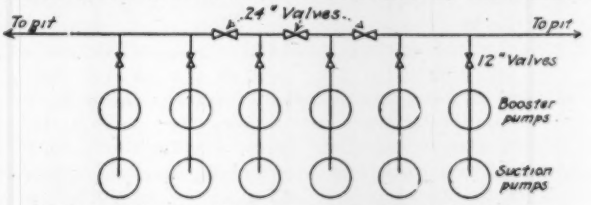


FIG. 5—VALVE ARRANGEMENT ON PUMP LINES

Fig. 5, each pair of pumps (suction and booster) discharges into a single line going two ways to the pits. Valves are located as marked. Any pair of pumps can be cut out and two, three or four pumps can deliver right or left to the pits while the others of the six deliver in the opposite direction. This arrangement gives notable flexibility of clear water supply to the giants.

On the diversion dam the plant consists of six 1,100-

g.p.m. clear water pumps operated by 75-hp. motors, and one 12-in. dredge pump with a 150-hp. motor. The clear water lines, one from each pump, are 6-in. pipe and the sluice pipe is 12-in.

Substantially all hydraulic fill for the terminal dam is a sluicing operation. Some of the fill from low points will be dredge pumped, probably about 15 per cent. In sluicing no open line is employed—every sluice line is 20-in. pipe. With a grade of 4 per cent there is no trouble, with ordinary care, in keeping the pipe clear. As ordinarily run, the stream is 6 to 9 per cent solids. With a grade flatter than 4 per cent clogging is risked and the sluice pipe has to be kept to true grade, without valleys, or there is the same risk. Sand gives no other trouble in sluicing, but the process has to be watched for action is rapid if once it starts.

Filling follows usual methods. As shown in Fig. 1 the sluice pipes are brought in from the dam ends. One ¾-cu.yd. and one 1-cu.yd. dragline excavator on crawler traction taking material from the beach throw up levees at the edges of the slopes. Filling proceeds back and forth along each beach. Beginning at one end, as the fill builds up, one section after another of sluice pipe is added until the lift is completed the full length of the beach. Then, working backward by shortening the sluice length after length, a return lift is built up. Repetition of these operations on both sides of the dam completes the fill. Fig. 6 is a view of the dam top showing the core pool and the flanking beaches. The section, Fig. 2, shows the overflow spillway for the core pool. No complications of any sort have come up in filling the lower third of the dam now constructed.

Electric Power—Virtually all construction equipment as described is electrically operated. The current comes in at 22,000 volts and goes to three 1,000-kva. transformers which step it down to 2,300 volts for the clear water pumps for the terminal dam. At the diversion dam the reduction is to 550 volts for the pumps. Here also are three 100-kva. and three 75-kva. transformers. At the main dam also there are three 100-kva. transformers stepping down from 22,000 volts to 440 volts. Altogether the motors on construction equipment represent 3,500 kva. The most notable operated unit is the pumping plant with its twelve 200-hp. motors, its pump and booster units in tandem and separately motored. Besides equipment the shops and a variety of camp services are electrically operated. Like the Saguenay River work, the Wilson Dam operations, and the Dix River dam in Kentucky, the installation here of electric equipment is one of the extraordinary uses of electricity for construction equipment operation. Here as in other places the reasons assigned for its use are reduction in fuel haulage and in machine attendance and a much cleaner operation generally.

FIG. 6—TOP VIEW OF HYDRAULIC FILL ON MAIN DAM

Personnel—The contractors for the development are the U. G. I. Contracting Co., Philadelphia, Pa., with W. M. Hall, construction engineer on the contractor's work in connection with the development, and Richard Byers, superintendent for the main contract which includes the large terminal dam. The sub-contractor for the diversion dam is the Briggs Engineering & Construction Co., Providence, R. I.

French Railway Development in Algeria

A new railway line has just been started in the western Algeria province running from the port of Beni-Saf on the Mediterranean, a small port, to Tlemcen, the distance being 60 km. On the line are two viaducts of more than 200 m. and a tunnel of 1,200 m. The line will carry two mixed freight and passenger trains each way daily. Another line of equal length, which it is proposed to electrify, will run from the port of Bougie in the eastern part of the province to Setif, tapping a rich agricultural region as well as certain districts susceptible of being exploited by the iron and copper mining industries. This will be constructed by private capital.

Predetermining Concrete Mixtures on Two Large Bridges

Abrams Method of Proportioning Concrete Used in Two Large Concreting Jobs for Railroad Bridges

PRACTICAL application of the Abrams methods of proportioning concrete on two large railroad bridges now under construction was described on Jan. 5 before the Philadelphia section of the American Society of Civil Engineers by T. P. Watson, assistant engineer of the Pennsylvania R.R. and A. E. Owen, chief engineer of the Central R.R. of New Jersey. The former, under the title "Practical Methods for Design of Concrete Mixtures," outlined the procedure followed in building the Becks Run Bridge of the Pennsylvania, a heavy concrete girder structure. Mr. Owen, in a paper "Newark Bay Bridge," described the proportioning methods used in building that structure.

Becks Run Bridge—On this bridge the engineers of the Pennsylvania R.R. closely followed the recommendations of Prof. D. A. Abrams contained in Bulletins 1 and 3 of the Lewis Institute Structural Materials Laboratory. The results have been highly satisfactory. Proportioning the cement and aggregates on the basis of fineness modulus, and using the slump test to insure the proper amount of water in the mix, they were enabled to predict almost exactly what the strength of the concrete would be. With the strength desired known and with the consistency of the concrete for the particular section determined, the proportioning of the concrete by the fineness modulus theory gave almost unbelievably accurate results. On the Becks Run Bridge, which Mr. Watson described, the strengths of the test cylinders consistently ran just a little higher than the prescribed design strength, although since cold weather these test cylinders have shown a slight decrease in strength at the 28-day period. The Abrams methods were easy to apply in the field, and, although the contract for the bridge had been let prior to the adoption of these methods, the contractor was not put to any additional expense (however, the railroad supplied the cement). It was found that the most important element in following the Abrams theory is the exact control of amounts of aggregate used. The effect of bulking due to moisture proved important. In the coarse aggregate (gravel) this bulking was almost constant, but it varied considerably in the sand.

The aggregates were transported directly from cars to the mixer, and as soon as a shipment was received a determination was made of the moisture content. This was done by taking four samples from each car, the material being obtained from about one-half the depth of the car, to represent average amount of moisture. If the moisture content of the aggregates changed after the samples were taken, as for instance due to rain, new bulking determinations were made.

The fineness modulus was measured and the slump determined which would give the desired consistency of the concrete. The proper proportions of the dry aggregates was then ascertained from Abrams' tables, to give the strength required. With the allowance made for moisture bulking the correct proportions were determined for the aggregates as taken from the cars. A measuring hopper facilitated the proportioning.

The amount of water used in making the concrete was constantly checked by frequent slump tests. All concrete was mixed for two minutes, and Mr. Watson believes this is essential. Colorimetric tests were frequently made to insure the quality of sand. Some mortar strength tests were made and the sand was found to be practically equal to standard Ottawa sand.

The work was under contract and rigid inspection, but the contractor became so imbued with the spirit of the job that he co-operated to the fullest extent in the endeavor to obtain the results desired. The railroad undertook the application of the method with much skepticism, but they are now convinced of its ease of practical application and are greatly pleased with the exactness of results. The engineers believe that by using these methods much better concrete structures will be obtained and designers will be able to proceed with far greater certainty in using stress factors, knowing that the strength of the concrete will accord with their assumptions.

Newark Bay Bridge—Mr. Owen did not go into the details of method as fully as did Mr. Watson, but in general the same practice was followed. The contract for the Newark Bay Bridge was let on specifications which called for proportions of cement to combine fine and coarse aggregate, the relative amount of fine and coarse aggregate to be determined by the engineer. The amount of water in the mix was also to be determined by the engineer. Here too the Abrams method was used, but owing to the excellent and uniform quantity of sand and coarse aggregate the proportioning was simplified. The bulking due to moisture was almost a constant factor. Mr. Owen used the slump test to control the mixing water, but he found that the man at the mixer could keep the water regulated to such a degree of exactness that control slump tests were made only infrequently. He confirmed the statements of Mr. Watson that the Abrams method was efficient, easy of application and sure in results.

The question was raised as to the applicability of the method when aggregates other than gravel are used. It was suggested that study should be given to this, and until the question should be determined care must be exercised against too wide an acceptance of the methods suggested.

On the Delaware Bridge also the Abrams method has been used with satisfactory results. A determination of proportions can be made within an hour after the receipt of a supply of aggregates.

In the testing laboratory of Philadelphia experience has shown that it is possible to predict within 10 per cent the strength of concrete of predetermined proportions according to the Abrams method. Richard L. Humphrey, chairman of the Joint Committee, told of the objections on the part of contractors to Clause 28 in the Joint Committee report when this was first suggested; now there is a far more favorable attitude. He stated he considered the provisions in this article to be the greatest forward step taken in the art of making concrete. Emile G. Perrot, architect, raised a question relative to the use of the Abrams method in cities where building codes definitely specify the proportions of cement and aggregate to be used for certain structures regardless of the fineness modulus or amount of slump.

Some Impressions of the Development of Hydraulic Laboratories in Europe

Extracts from a letter written by John R. Freeman, Consulting Engineer, Providence, R. I., following a visit to noteworthy hydraulic laboratories in Europe

FAIRLY astonished was I by the development in hydraulic laboratories which I found in Europe, particularly at the technical high schools at Charlottenburg, Brunn, Karlsruhe and Dresden, and I was told that developments of almost equal interest could be found at Darmstadt, Danzig and Vienna. I had a delightful half day with Prof. Emeritus Hubert Engels at Dresden, who arranged some stunts for my special benefit as a hydraulician. And I found that Professor Nagel, who had charge of mechanical engineering at Dresden, had an independent laboratory for the study of hydraulic motors which was more complete in its refinement than anything I have seen in America. At Munich, I failed to make my intended visit to the hydraulic laboratory for mechanical engineers at the technical high school, by reason of the extra time spent with good Dr. Oskar von Miller, head of the Deutsches Museum, who had about 100 workmen busy refitting everything for a reopening and has everything arranged for stimulating invention.

Germany seems to have plenty of money for keeping its technical laboratories fully up to date, and plainly their industrial leaders are right now getting ready for an industrial conquest of the world at large. In this, I check up exactly on the views of E. J. Mehren following his recent visit to Germany, published in *Engineering News-Record*.

Recent Progress—I was astonished at the development since my visit of eleven years ago in the application of laboratory models on a scale of 1 to 100—or in some few cases 1 to 10—for the solution of great river-flow problems. Also in the use of experimental flumes with glass sides and a photographic record. They have worked out the laws of similitude for models of hydraulic structures most remarkably. Plainly, the government has found plenty of money for this kind of development, particularly at Karlsruhe, where an entirely new laboratory within new buildings was constructed about two years ago to take the place of the one built twenty years ago. This work also was helpful to mechanics during the period of unemployment. Professor Rostock tells me that now, after two years, he would like to build a third with improvements. Rostock is an exceptionally high-class man. He seems to be a consultant on large outside hydraulic problems, which he takes into his laboratory. But plainly, he is true and faithful to his first love—his professorship and the laboratory. He told me quietly, and evidently with great pride, that he expects to become Rektor of this famous 100-year old school next year at about the time of its centennial celebration.

Success of Laboratory Experiments—Professor Rostock made the remarkable statement that in every one of the major hydraulic problems which he has taken from out-of-doors into his laboratory for solution, the saving in cost of the structures by reason of the research has been sufficient to pay the entire cost of the new laboratory building and its apparatus.

These problems, of which he showed me photographs of experiments in progress, had embraced the proper form of longitudinal section and cross-sections of conduit bed for taking mountain torrents across the top of St. Gothard railway tunnels, where the boulders and cobblestones had been pounding holes in the roof, but which he has now shaped so that the stones slide over gently, hardly more than scratching the surface instead of jumping and pounding. Secondly, he showed me photographs of a series of studies for the best form of waterway entrance, channel and exit for a diversion of the river at Nürnberg, where he had concentrated the channel into wonderfully small compass, and with small loss of energy at the entrance, by a long weir, shaped like the letter W inverted, and carefully worked out cross-sections made up in plaster of paris models on a scale of about 1 to 40, patiently working toward perfection with 5 successive models, each giving better results than its predecessor.

Next he showed me models of one of the larger rivers of Germany, with plans for regulating its flow beneath a bridge at the foot of a high overfall having a "hydraulic-jump" and told me that his predictions of flood height, based on his laboratory models, was within from 4 to 2 per cent, or near enough for all practical purposes, to the amount found subsequently in the field. He tells me that he has worked out the relation between model and the out-of-doors structure so satisfactorily that he is now satisfied to make his models on a smaller scale than formerly. Nearly all that I saw at Karlsruhe and Charlottenburg were on a scale of 1 to 40 or 1 to 100. Professor Rostock had a dozen or fifteen assistants and post-graduates at work during vacation upon research for practical out-of-doors problems, including the design of flood sluices for the drainage of the Zuider Zee, etc., etc., and his general layout of apparatus puts to shame anything that I have seen in any American hydraulic laboratory.

Professor Rostock showed me many illustrations of what can be done by experimenting on models and in tanks with glass sides, where he had experiments in progress for finding the most economical means of taking the energy out from the current that has fallen over a dam, and showing the path of the eddies by black balls of various sizes of about the same specific gravity as the water, which he threw in at various points upstream while I watched their path.

I wish that one of our leading technical schools would find some way to invite Dr. Rostock to America for a half year as an exchange professor, and in the meantime, ask him to design a laboratory suitable for the school. I would guess that all the tanks and apparatus he had to show me, exclusive of the building, could be duplicated for, say, $50,000.

Designing by Models—At Charlottenburg, great courtesy was shown me by Dr. de Thierry and his colleague, Dr. Krey, hydraulic expert for the German Naval Administration, who showed me everything without reserve.

Dr. de Thierry showed me a big model constructed (I think) 1/40 of the full size, for a new lock for the canal from Amsterdam to the North Sea, which is to be somewhat bigger in area than the locks at Panama, although of smaller lift, and showed me how, by means of research on methods of filling through the breast wall with a special form of gate, he had been able to change the design so as to effect a saving of about

$600,000, by devising gates so as to avoid surge and disturbing commotions within the lock and obviate the need of the intricate and costly passageways through side walls and lock floors which are commonly built. Also, he showed me another apparatus for smaller canal locks in Germany for effecting the changes of level without any troublesome agitation of the boat. This was worked up with beautifully designed apparatus for recording and measuring the oscillations of the masthead of a boat in lockage during filling, first with the old-time gate, and second, with the successive improvements in anti-commotion gates.

He also showed me a model for testing a proposed improvement of the navigation in one of the channel rivers, whereby a shallow channel along the side, with its lesser velocities, would be used by up-going canal boats, while the down-going boats would take the main channel. He showed that, although this looked so good on paper and in theory that it had been proposed to try it out in the real river, the transfer of the problem to the laboratory had demonstrated its lack of practicability by showing how a sort of rotary component of the current would continually drag the up-going boat out into the main channel. Obviously it is far cheaper to try out such schemes in a laboratory on a 1 to 40 model than in the real river.

Dr. de Thierry's most wonderful model was one of a new harbor arrangement where they propose building an enormous new dock for the biggest kind of boat, like the Leviathan and the Majestic, and desired to learn the effect of a change of current upon the sand bars and mud deposits in the harbor. The model was truly wonderful in its completeness of reproducing the topography, but more particularly in its clockwork mechanism for simulating the changing tides and occasional great flood. Attached to this complete model Dr. de Thierry showed me five different kinds of water current control, which could all be set working by the clock and would continue their effect on moving the grains of sand about the harbor for a sufficient period to establish the regimen. They also had a model of a big steamboat available for mooring at the dock, to show what difference this would produce in the current.

Even at Brunn in Czechoslovakia I was astonished at the quantity, extent and up-to-date work of their hydraulic laboratories. They have a big tank with plate-glass vertical front and a blackboard in the rear ruled off in squares whereby they were testing out models for the shapes of dams and showing the paths of the currents and eddies upstream and downstream from the dam by throwing grains equivalent to white sawdust into the current while a beam of electric light and a camera recorded their relative velocities and successive positions. Also, they had been experimenting on models for the further development of the siphon spillway, one of the very latest things in flood relief development.

I was so profoundly impressed by all of this progress in the use of small models in the laboratory for solving the big problems out-of-doors that I urged upon my good friend Dr. Conrad Matschors, now secretary of the German National Engineering Society, the preparation of a series of monographs about each of these laboratories and its contributions to hydraulic science, to be published first in German and later in English. This has met with a most hearty response and a book which we expect will contain 500 pages is now in preparation by ten of the foremost hydraulic laboratory men of Europe.

I am sure this demonstration of what can be done with small scale models in hydraulic experimentation will have in due course a great influence upon teaching in American and English technical schools, and in practical works for American river and harbor improvement.

Composite Wood and Concrete Pile Rises Above Water Line

Costly and Difficult Foundation Work Avoided by Concrete Pile Heads Carrying Footings Above Water-Bearing Soil

COMPOSITE PILES of concrete and timber with steel sleeve splices, as used for the west approach of the viaduct carrying South Park Boulevard over the Illinois Central R.R. at Chicago, represent a new development in foundation design. For the abutments and piers the foundations consist of 94 concrete cylinder piers seated on bedrock about 85 ft. below grade or 70 ft. below lake level. At the west approach is a plaza of reinforced concrete with a deck of the flat slab type, about 25 ft. above street grade and supported by 140 columns 14 ft. to 38 ft. c. to c., but in general the spans

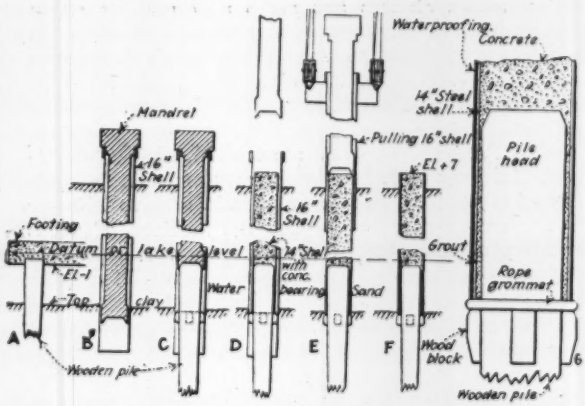


FIG. 1—STAGES OF WORK ON COMPOSITE PILES
A—original design; B—mandrel drives 16-in. steel shell; C—mandrel drives wood pile; D—14-in. shell driven and concreted; E—withdrawing 16-in. shell; F—finished composite pile; G—sleeve joint of composite pile.

are 23 to 25 ft. No columns obstruct the driveways and sidewalks on the lower level.

Although this plaza is close to the lake and the street grade is 14 ft. above datum (lake level), the ground water level was found at 7 to 8 ft. above datum, the ground consisting of water-bearing sand from 7 ft. above to 5 ft. below datum. Pile foundations were specified, but as the city ordinances require wood piles to be cut off 1 ft. below datum it would have been necessary to extend the concrete foundation work down through the water-bearing sand, involving sheeting and pumping for the excavations. Preliminary borings indicated that piles would have to be driven to about 55 ft. below datum and the contract was based on piling of that length.

To meet these conditions the contractor submitted

several designs for composite piles consisting of wood piling below datum and concrete sections above, thus raising the concrete footings from 1 ft. below to 7 ft. above datum. The specifications permitted the substitution of composite piles with the following limitations: "The minimum diameter of the concrete pile sections shall be not less than 13 in., the specified minimum diameter of the wood pile, and the connection between the wood and concrete portions of the pile shall be designed to resist bending as well as vertical loads; the design shall be subject to the approval of the engineer and consulting engineers." None of the first designs fulfilled the requirement that the joint between the concrete and wood sections should be equal in transverse strength to the wood pile, which requirement was considered necessary because it is anticipated that there will be excavations around the plaza for sub-basements extending below datum. The type of pile finally approved and now being driven, consists of a wood pile and a waterproofed steel shell surrounding 30 in. of the pile head and extending up to the footing, this shell being filled with concrete. All of the wood pile is below the plane of permanent saturation. Fig. 2 shows the work in progress; Fig. 1 shows the several stages of the work.

These piles are made and driven as follows: First, the 16-in. steel driving shell, about 22 ft. long and ½ in. thick, is driven by a steel mandrel which completely fills the shell except that it is about 1 ft. shorter than the latter. This mandrel and shell are driven down to the required depth, so that the end of the shell is well through the water bearing sand and into the impervious clay beneath. The mandrel is then withdrawn and the wood pile, the upper end of which has been trimmed to a maximum diameter of 13 in. for at least 2½ ft. of its length, is lowered into the shell until it rests on the clay. This pile is then driven by the mandrel to the specified limit of penetration, namely not more than 6 in. for 18 blows of a 45,000-lb. hammer falling 3½ ft. at a rate of 54 blows per minute. The top of the pile must be not more than 2 ft. above datum and may be as much below as the length of the apparatus will permit, but there must be not less than 30 in. of the wood pile remaining inside of the driving shell. About 30 in. below the top of the wood pile are attached wood blocks to center it inside of the shell; at the top of these scabs is a rope grommet to act as a seal to prevent the admission of water and sand.

After the wood pile is in position, the mandrel is withdrawn and a 14-in. steel shell, protected outside with asphalt membrane waterproofing, is lowered into the 16-in. driving casing and is forced down over the end of the wood pile for a distance of 30 in. by a driving mandrel. On removal of the mandrel a wheelbarrow of cement grout is deposited in the 14-in. shell to fill the space around the head of the pile. After thus sealing the shell, the mandrel is placed on top of it to hold it in position and the outside driving casing is withdrawn by heavy tackle, as shown in Fig. 2, permitting the ground to fill in against the waterproofed surface of the 14-in. shell. This shell is then filled with concrete. Some upper sections of the concrete filled shells which have been cut off show that the concrete has set up perfectly hard and solid. More than one-third of the 800 piles required for this foundation have been driven and while there were the usual difficulties at the beginning the work has since progressed smoothly.

By this method the expense of sheeting and pumping has been avoided, as well as the delays and uncertainties which usually attend work through water-bearing sand. The agreement with the contractor calls for a

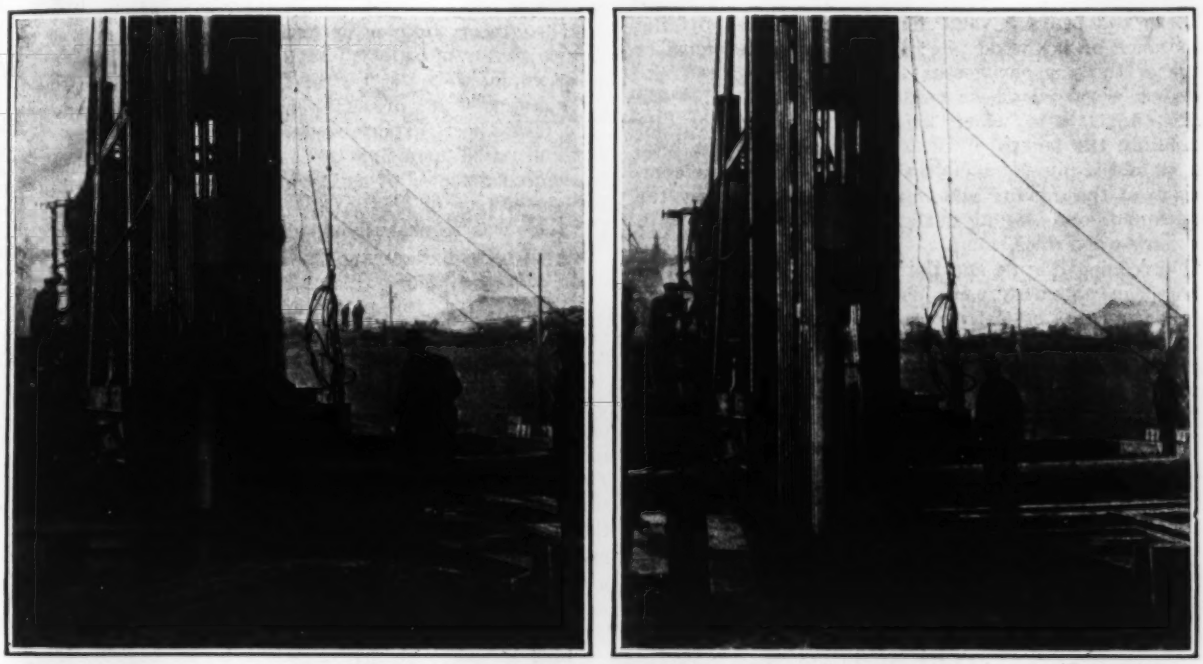


FIG. 2—MAKING COMPOSITE PILES FOR CHICAGO FOUNDATIONS

Left—Pile driver hammer rests on mandrel for driving 16-in. steel shell; blocks are attached to head for pulling this shell. Right—Permanent 14-in. steel shell in place, extending above head of wood pile; mandrel rests on this shell to hold it while hoisting blocks pull up temporary 16-in. shell. All of wood pile is below the level of permanent saturation.

deduction from the amount of his proposal if permitted to substitute this type of pile in place of the specified design of wood piling with the bottom of the footings 1 ft. below datum. While the credit allowed was not great, it was felt that there would be a saving of time and much less likelihood of delay. Some of the advantages claimed for the use of this type of pile are: (1) The waterproofing is completely protected from possible injury due to driving, either by friction of the surrounding soil or by jarring during the process of placing; (2) as the wood pile is under full control during the driving it can be kept plumb; (3) the finished pile has the friction bearing value of the additional length of the permanent shell, this being an addition to the bearing value determined by the driving resistance of the wood pile; (4) the over-all length of some of the piles driven has exceeded 75 ft., and had standard wood piles been used some would have been at least 65 ft. long, which lengths are expensive. By extending the length of the concrete section, the total length of the pile is variable at any time up to the completion of the driving and is not predetermined by the length of the pile swung in the leads, as is the case with ordinary wood piles.

This composite pile and the method of driving, which have been patented, were developed by the Western Foundation Co., of Chicago, sub-contractor for the pile foundations. The viaduct and approaches were designed by Condron & Post, Chicago, consulting engineers to the South Park Commissioners. The structure will cost about $1,300,000 and is to be completed by the fall of 1925.

Bursting of Boston Molasses Tank Found Due to Overstress

Auditor Rejects Bomb-Explosion Theory and Holds Collapse Chargeable to Inherent Weakness of Tank

AFTER nearly six years of litigation the noted Boston molasses tank case has reached a preliminary decision in the form of an auditor's report by Col. Hugh W. Ogden, whom the Massachusetts Superior Court in 1920 appointed to hear testimony. The tank in the case, a 2½ million gallon circular steel-plate tank 90 ft. in diameter by 50 ft. high used for molasses storage by the U. S. Industrial Alcohol Co., burst on Jan. 15, 1919, about noon, when practically full; 21 persons were drowned or otherwise killed and much property damage was done, including the partial wrecking of the steel elevated-railway structure in Commercial St., alongside the tank. More than 100 damage suits led to the appointment of the auditor to report on the facts of the case. Taking testimony consumed three years, August 1920 to September 1923. Much expert testimony was presented by both sides. The facts of the collapse were given, so far as they could then be learned, in *Engineering News-Record* of Feb. 13 and May 15, 1919, pp. 353 and 974, and notes on the testimony were given Oct. 17, 1920, p. 691, and Sept. 1, 1921, p. 372.

In the failure the shell of the tank tore open on one side and spread out; the main break passed through a manhole in the lower ring and then through solid metal, but farther up the breaks ran largely through the riveted joints. The plaintiffs contended that the tank failed because it was weak, while the defendant contended that a bomb explosion in the tank caused the disaster. The auditor rejects the explosion theory, finding not a single item of evidence to support it; in his judgment the tank was too weak and failed because of its weakness.

According to the report the tank was ordered of the Hammond Iron Works in 1915 by the Purity Distilling Co. on authorization of the Alcohol company. It was ordered to a factor of safety of 3, for storage of molasses weighing 11½ lb. per gal.; there do not appear to have been any other specifications except those written by the builders. The treasurer of the Purity company, a non-technical man, ordered it, without consulting any "engineer, builder or architect as to what was a proper factor of safety," says the auditor. The tank was completed by the first of 1916, and was tested only by running 6 in. of water into it. "The Hammond Iron Works were experienced and reputable makers. . . . Mr. Jell relied upon their skill and experience. He supposed that a factor of safety of 3 was providing amply for the safety of the tank." After it was in service the tank was several times calked.

On 11 occasions during its three years of service the tank contained more than 1,900,000 gal., for periods up to 25 days, the maximum ever contained being 2,350,848 gal. and the content at the time of failure 2,319,525 gal., which had been in the tank four days.

Structurally the tank comprised 7 shell rings, about 7 ft. wide; a flat bottom resting on a cement-sand cushion on a concrete foundation; and a conical steel-plate roof supported by framing. The bottom course (Ring 1) contained a 21-in. manhole. The shell-plate thicknesses were somewhat less than those stated in the company's plan and application for a building permit, thus:

Ring	Plan	Actual	Ring	Plan	Actual
1	0.687 in.	0.667 in.	5	0.375 in.	0.335 in.
2	0.625 in.	0.592 in.	6	0.312 in.	0.296 in.
3	0.500 in.	0.482 in.	7	0.312 in.	0.284 in.
4	0.437 in.	0.413 in.			

Ring 1 had triple-riveted butt joints in the vertical seams, the other rings triple-riveted lap joints.

After the collapse the main fractures were a vertical break through Ring 1 passing through the manhole and a diagonal break about 20 ft. away. The shell piece between these breaks with a small section of bottom plating attached was found 182 ft. away; it weighed 2½ tons and is referred to as Piece "A." The other part of the manhole and the cover were 107 ft. from their original position, in another direction. The rest of the shell tore into two large sections, one of which had a small piece broken off by hitting an elevated-railway column. The bottom remained in place, and the roof fell as a unit. The tank lay in only seven pieces. The steel is declared of good quality.

Brief extracts from the auditor's report follow:

The available direct evidence as to what occurred at the instant of the collapse of the tank is strangely meager . . . The sounds connected with the accident give us no aid in determining affirmatively whether the tank collapsed through some defect in material or design or whether the collapse was due to an explosion . . . I do not find that there was smoke arising from the tank at or about the time of the accident. In like manner, the evidence in regard to broken glass does not impress me.

. . . The defendant's experts called attention to the presence of Neumann bands, so-called, and emphasized the

claim that the presence of Neumann bands in steel of the character herein considered which had been fractured was a proof that the steel in question had been very suddenly fractured and that such bands would not appear if such fracture had been caused alone by static pressure produced by the load of molasses . . . In the present state of science, however, I find that the conflicting authority in regard to where they occur, when they occur and why they occur is too fundamental to give their presence any weight in marshaling the proofs in this case.

. . . Piece "A", torn from its surroundings, after the accident lay by itself in the playground, 182 ft. east of the tank . . . The views of the defendant with regard to the significance of piece "A" in its location are thus stated, "It took a tremendous force to carry it that distance and no force exerted by the fluid molasses as it was poured out over the playground could have carried it any such distance. The specific gravity of it is too heavy for it to have been thrown that distance. It must have been hurled by a tremendous force to that distance of 175 or 180 ft." . . . I do not believe that piece "A" was thrown to its destination by an explosive. I do believe there was sufficient pressure in the volume of molasses at its then height when released to carry piece "A" to the position in the playground where it was ultimately found.

The evidence in the case seems to me fairly to require a finding that intelligent inspection would have demonstrated to the defendant the danger in the lap seams from the so-called weeping or leaking of molasses . . . The testimony of disinterested witnesses who swear that the tank was leaking to such an extent as to attract their attention, although they had no individual interest in the tank itself, seems to me material evidence that the condition of the joints was being affected to their detriment by high stresses . . . I cannot help feeling that a proper regard for the appalling possibility of damage to persons and property contained in that tank in case of accident demanded a higher standard of care in inspection from those in authority.

. . . The proposition advanced by the plaintiff is that the tank was too weak to stand the strain of 2¼ million gallons of molasses. The counter proposition advanced by the defendant is that the tank was amply strong to stand that strain. These two propositions are fundamental and irreconcilable. . . . The factor of safety in this tank was calculated by one of the experts of the defendant as 2.3 below the manhole in Ring 1 plate. The factor of safety as computed by another expert for the defendant at the manhole was somewhere from 1.8 to 2. Defendant's expert also testified that he found in Ring 5 at a vertical joint a factor of safety of 2.3, in Ring 3 in the vertical joint a factor of safety of 2.3, in Ring 2 in the full plate a factor of safety of 2.4, in the riveted joints of Ring 2 a factor of safety of 1.7, in Ring 1 in the riveted joints a factor of safety of 1.95. An experiment by one of the plaintiff's experts on the lap joint of the second ring gave the ratio of the breaking load on this joint to the equivalent load on the joint when the tank was filled to 48 ft. 9 in. as 1.43 . . . The question for determination, therefore, is whether the above factors of safety which the tank had, furnished a sufficient margin of strength to take care of the secondary stresses.

At the outset I am faced with the evidence of the defendant's own experts that while in their opinion the tank was safe as built they would not build it in the same way if they were called on today to design a tank to hold the same load . . . The unanimous opinion of the experts for all parties, therefore, indicates a desirable increase in the thickness of the lower plates and an increase in the factor of safety, the only difference between the experts of the defendant and the experts of the plaintiff being that the former are of opinion that the tank was "safe" at the time of the collapse. I cannot help feeling that in their position the defendant's experts do not quite have the courage of their convictions as stated . . . What justification can there be for increasing the size of the plates, raising the factor of safety and thus strengthening the tank if the tank was properly designed and "safe" for every purpose for which it was designed as it stood on the fifteenth of January, 1919?

. . . I believe and find, however, that the high primary stresses, the low factor of safety, and the secondary stresses, in combination, were responsible for the failure of this tank.

In a concluding paragraph the auditor comments specially on the mass of conflicting expert testimony. Some passages are:

. . . Weeks and months were devoted to evidence of stress and strain, of the strength of materials, of the force of high explosives, of the bursting power of gas and of similar technical problems. . . . I have listened to a demonstration that piece "A" could have been carried into the playground only by the force of a high explosive. I have thereafter heard an equally forcible demonstration that the same result could be and in this case was produced by the pressure caused by the weight of the molasses alone. I have heard that the presence of Neumann bands in the steel herein considered along the line of fracture proved an explosion. I have heard that Neumann bands proved nothing. I have listened to men upon the faith of whose judgment any capitalist might well rely in the expenditure of millions in structural steel, swear that the secondary stresses in a structure of this kind were negligible and I have heard from equally authoritative sources that these same secondary stresses were undoubtedly the cause of the accident. Amid this swirl of polemical scientific waters it is not strange that the auditor has at times felt that the only rock to which he could safely cling was the obvious fact that at least one-half the scientists must be wrong. By degrees, however, what seem to be the material points in the case have emerged. . . .

The total of damage claims affected by the decision is said to exceed $300,000.

Teredo Destroys Piles in 2½ Months

DURING the past year the attacks of teredo on piling in the upper reaches of San Francisco bay and the deltas of the Sacramento and San Joaquin rivers have been of unusual extent and severity. Some temporary piles driven in May at the pier-head in Carquinez Strait directly opposite the town of Valona were continually watched by divers for teredo attack. No attack was observed until some time during the period between July 1 and July 15, and thereafter the

SECTIONS OF PILE LITERALLY EATEN UP BY TEREDO

attack progressed so rapidly that the piles failed completely about Sept. 19, i.e., were unable longer to hold their own weight.

The accompanying illustration shows longitudinal and cross-section views of one of these piles in which the destruction was completed in about 2½ months. The teredo activity was almost as severe at the low-water line as it was at the mud line, and this extended over a considerable length of pile as the water is about 20 ft. deep at this point.

For the illustration and the foregoing data *Engineering News-Record* is indebted to engineers of the American Toll Bridge Co., who made the observations to which reference is made.

Precipitation and Runoff at the Continental Divide

A Discussion of the Apparent Disparity in Precipitation and Runoff, with an Analysis of the Data in the Light of Snow Surveying

By J. E. Church, Jr.
Director of Mount Rose Observatory;
In Charge, Nevada Co-operative Snow Surveys, Reno, Nev.

and E. H. Jones
Meteorologist, U. S. Weather Bureau,
and formerly in Charge, Wagon Wheel Gap Experiment Station

With a Discussion by H. P. Boardman
Professor of Civil Engineering, University of Nevada, Reno, Nev.

Introduction

On noting the article on "Precipitation and Runoff Near the Continental Divide," by Robert E. Horton, in *Engineering News-Record*, Feb. 28, 1924, p. 355, I decided that this was a case of drawing conclusions from insufficient field data and that the field data which would contribute the most towards solving the difficulty could be obtained only by properly conducted snow surveys, assuming that the runoff data available were on a par with the usual data of that kind published by the U. S. Geological Survey. I therefore showed the article to Dr. J. E. Church of the University of Nevada. On account of his extensive experience with snow surveys in the Sierra Nevada and the fact that he has developed the best system of making snow surveys that has ever been practiced extensively [*Engineering News-Record*, Feb. 10 and 17, 1921, pp. 244 and 300.] I consider that he is one of the most competent men living to discuss the factors of this problem. At the end of his discussion I append a digest of it from the viewpoint of the engineer.

—H. P. Boardman.

THE DISCREPANCY between the measured runoff of the streams at high elevations along the Continental Divide and the measured precipitation at available stations has led to discussion regarding the scientific aspects of the phenomena (see *Engineering News-Record*, Feb. 28, March 20, and May 15, 1924, pp. 355, 502 and 871). Mr. Follansbee believes that the apparent excess runoff is due mainly to the absence of intercepting mountain ranges to westward and the absence of precipitation stations on exposed slopes at high altitudes, while Mr. Horton suggests that the excess may well be due to the snow formed at lower levels being carried locally up the slope and deposited at higher elevations.

The keen interest aroused by the argument has drawn the senior writer, at the suggestion of Professor H. P. Boardman, University of Nevada, to re-analyze the data in the light of snow studies in the Sierra Nevada and Basin ranges. The junior writer was included because of his knowledge of local snow conditions in Wyoming and Colorado.

The points involved in the discussion are: (1) Source of precipitation; (2) increase in precipitation with elevation; (3) effect of barrier ranges; (4) transport of snow; (5) instrument errors; (6) uniformity and diversity of precipitation over wide areas and locally; (7) re-comparison of adjusted precipitation measurements and measured runoff; (8) probable correction factor for water losses; (9) value of snow surveying.

I. *Source of Precipitation*—The relatively heavy precipitation in the Rocky Mountains, which gives rise to the immense Columbia, with its mean flow at The Dalles of 151,700,000 acre-ft. and to the lesser Colorado with 17,500,000 acre-ft., inevitably raises the query whether the precipitation on the Continental Divide does not come mainly from the Gulf of Mexico rather than from the Pacific Ocean. The answer is negative for three reasons:

1. The storm movements are consistently from west to east and rarely "back up" from the Gulf.

2. The centers of depression passing over the western United States seem almost uniformly to have a dry front, thus indicating that the attending moisture is not drawn in from the east or southeast but follows the depression from the west. This is particularly true as far as the Continental Divide. Furthermore, for some distance to the eastward of the divide, this dry front still appears in possibly 50 per cent of the instances studied. However, toward the center of the Mississippi Valley the front of the depression becomes uniformly wet, indicating the preponderance of the nearer sources of moisture in the Gulf of Mexico, the Great Lakes, and the Atlantic Ocean.

3. The seasonal distribution of precipitation on the western or windward side of the Continental Divide resembles that on the Pacific slope, where the bulk of the precipitation falls in winter, and on the eastern or dry slope still represents it, though in an attenuated way, until within a short distance from the Gulf. This is best shown by comparing the following percentage of winter precipitation (Nov.-March) to its annual total: Portland, 54.7; Salt Lake City, 46.7; Lay (Colo.), 42.9; Climax (crest of Continental Divide), 53.7; Pikes Peak, 32.5; Amarillo, Texas, 18.3; Galveston, 36.9.

The low percentage east of the Continental Divide seems to be due to the fact that local summer storms comprise by far the larger part of the annual precipitation. Along the more southerly storm track, as from San Francisco eastward, the percentage of winter precipitation to its annual is as follows: San Francisco, 80.3; Fordyce dam (near crest of Sierra Nevada), 76.4; Salt Lake City, 46.7; Rico (Colo.), 51.9; Climax, 53.7, the relative precipitation in the Sierra Nevada being much greater than at Portland.

The absolute winter precipitation at the crest of the Sierra Nevada, represented by the snow cover of 41.76 in. on April 1 at Summit Station, after diminishing apparently by more than 75 per cent over the drier and warmer Great Basin (compare 7.48 in., Nov.-March, at Salt Lake City), regains or displays 50 to 66 per cent of its former moisture effectiveness when forced to high elevations in the Wasatch Range and on the Continental Divide, as shown by the snow cover of 25.71 in. in Brighton Basin at El. 8,700 to 9,540 ft. in the former and 19.40 in. winter precipitation (Nov.-March) at Climax at the crest of the latter. The slight increase in precipitation at Salt Lake City (El. 4,292 ft.; Nov.-March precipitation 7.48 in.) over Lamoille, eastern Nevada (El. 6,100 ft.; Nov.-March precipitation 7.27 in.), despite decrease in elevation, may indicate the

influence of Great Salt Lake in supplying moisture to the passing air. However, in general the Great Basin is too arid to furnish appreciable moisture except in the depth of winter when evaporation is lowest.

The phenomenon of two gigantic streams, the Columbia and Colorado, springing from the Continental Divide and the Great Basin fades in the light of the fact that the transverse axes of the heads of these streams extend jointly 1,200 miles along the Continental Divide, or, if the Gila, the southern though diminutive feeder of the Colorado, is included, a total distance of 1,600 miles. Their basins, much of which however is dry, have a joint area of 462,000 sq.mi., or one-seventh of the area of the United States.

II. *Increase in Precipitation with Elevation*—With Mr. Horton, the senior writer has always believed that the elevation of maximum precipitation was lower than that indicated by precipitation measurements on the Continental Divide, probably because the zone of mean maximum precipitation in the Sierra Nevada Mountains has always been assumed to be between 4,500 and 6,500 ft., although the neighboring passes are approximately 7,000 ft. in altitude and the mountain crests approximately 9,000 feet.

TABLE I—INCREASE IN PRECIPITATION WITH ELEVATION
(Inches Water Content)

	Elevation Ft. above sea level	Precipitation Annual (U. S. W. B.)	Precipitation Nov.-March (U. S. W. B.)	Snow Cover April 1
1. Sierra Nevada				
Sacramento	71	20.09	15.56	
Fordyce dam	6,500	68.90	54.47	46.24
Summit Station	7,017	46.23	37.24	41.76
Tahoe City	6,230	31.40	25.59	16.74
Reno	4,532	8.35	5.61	
2. Ruby Mountains				
Lamoille	6,100	16.54	7.27	
Lamoille canyon	9,000			approx. 14.33
3. Wasatch Range				
Salt Lake City	4,292	16.03	7.48	
Big Cottonwood Creek	6,880—8,530			13.79[1]
Brighton basin	8,700—9,540			25.71[1]
4. Continental Divide				
Lay	6,190	12.70	5.45	
Rico	8,824	24.80	12.88	
Climax (crest)	11,304	36.11	19.40	
Leadville	10,248	13.94	6.31	
Colorado Springs	6,098	14.28	1.77	

[1] Meas. by Salt Lake City. See *Monthly Weather Review*, 40 (June, 1916) p. 360 by Burton.

However, an analysis of the snow cover at high elevations indicates that the zone at least of maximum winter precipitation may be as high as the range both on the windward side and necessarily on the leeward, where the precipitation rapidly diminishes with decrease in elevation. The only apparent exception to this increase is in the Sierra Nevada where the difference between the maximum snow cover at 6,500 ft. at Fordyce dam and the snow cover at the crest at Summit Station (7,000 ft.) is only 4.48 in. water content. If the comparison is extended to Blue Canyon (4,695 ft.), where the Nov.-March precipitation is 1.64 in. greater than at Fordyce dam, though the actual snow cover is less, the difference between the winter maximum in the Sierra Nevada and at its crest may be assumed to be 6.12 in. The rain gage measurements, however, indicate a difference of 18.87 in., the measured precipitation at Fordyce dam being 8.23 in. greater than the snow cover, as might be expected, while that at Summit Station is 4.52 in. less than its corresponding snow cover. This increase with elevation and corresponding decrease to leeward, both with and without decrease in elevation, is shown in Table I. The profile includes not only the Sierra Nevada but the succeeding Ruby and Wasatch ranges in the Great Basin and Continental Divide.

The basic fact deduced from the table is that, with the slight exception of the Sierra Nevada, the winter — and consequently the summer — precipitation increases from the base to the crest of the range. These measurements have been furnished by Follansbee and J. M. Sherier, in charge of the Denver office of the U. S. Weather Bureau:

	Elevation Ft.	Precipitation, In. Water Annual	Nov.-March
Pikes Peak	14,111	29.55	9.60
Lake Moraine	10,265	24.75	5.16
Fremont exp. sta.	8,836	21.80	3.85
Glen Eyre	6,500	16.15	
Colorado Springs	6,098	14.28	1.77

III. *Effect of Barrier Ranges*—The effect of barrier ranges in reducing precipitation is convincingly shown in both the Sierra Nevada and on the Continental Divide not only by the sharp diminution of precipitation on the leeward side of all ranges (see Table I) but also by the diminution of precipitation even on the windward sides and crests of ranges parallel to but to leeward of others of similar or greater height.

IV. *Transport of Snow*—The transport of snow may be doubly interpreted: (a) as the carrying forward and upward of condensing moisture beyond the level where it should normally fall, and (b) the transport of fallen snow. It is in the former sense that Horton uses the term, although he considers erosion as an important factor in the distribution of snow.

Transport of Condensation—Like the waves of the sea, the waves of vapor are limited in length only by relative thinness or lack of viscosity of the air as compared with water. Their actual length is indicated by the distance between cloud crests in the sky. However, like the waves of the ocean beating on a rocky coast, the waves of vapor must be relatively short because of the rising slope, and even at mountain crest they should not be much longer than the snow plumes blown from mountain peaks in a gale.

TABLE II—EFFECT OF BARRIER RANGES IN DIMINISHING PRECIPITATION

	Elevation Ft. above sea level	Precipitation, In. Water Annual (U. S. W. B.)	Nov.-March (U. S. W. B.)	Snow cover April 1
1. Sierra Nevada				
(a) Main Cham				
Summit Station	7,017	46.23	37.24	41.76
Tahoe City	6,230	31.40	25.59	16.74
(b) Carson Range				
Incline	6,230	.....	.....	approx. 7.37
Mount Rose	9,000–10,800	.....	.....	26.56
Reno	4,532	8.35	5.61	.....
2. Rocky Mountains				
(a) Crest				
Climax	11,304	36.11	19.40	.....
Leadville	10,248	13.94	6.31	.....
(b) Eastern Spur				
Pikes Peak	14,111	29.55	9.60	.....
Colorado Springs	6,098	14.28	1.77	.....

It is difficult to determine by actual measurement the amount of transport up windward slopes, because the influence of elevation in increasing precipitation must necessarily becloud the effect of transport. The only illustration available is doubtful. On the northern end of Ruby Mountains in eastern Nevada, transverse to the

movement of the wind, the increase in precipitation from El. 7,000 to 9,000 ft. is approximately 5.09 in., whereas in the Wasatch Range, where the slope faces the wind, the increase between El. 7,700 and 9,120 ft. is 11.92 in. How much of this preponderance is due to vapor rising from Great Salt Lake is uncertain. A snow survey course on the windward side of Ruby Range for comparison with that on the transverse northern end would solve the problem, providing the general ruggedness of the range does not make measurements inaccurate.

However, the evidence regarding absence of transport to any considerable distance beyond the crest is convincing. At the immediate crest of the Sierra Nevada, the intensity of precipitation appears to be as great on the leeward as on the windward side of the divide, as shown by the following courses: Webber Peak (east of divide), 44.51 in.; Summit Station (west of divide), 41.76 in.; and Ward Creek (east of divide), 42.21 in. These stations are approximately ten miles apart and the courses are within half a mile of the divide. Unfortunately, these stations have no courses on the opposite side of the divide to confirm the conclusions. Beyond this half-mile limit, the intensity of precipitation decreases rapidly, even at similar elevations, the snow cover in Ward Creek decreasing from 42.21 in. near the divide to 25 in. at Pages Meadows, two miles eastward, a loss of 17.21 in. Both stations are on the 7,000-ft. contour. The rapidity of decrease is:

Station	Elevation Ft.	Distance from Preceding Station, Miles	Snow Cover In. Water Content	Loss In. Water Content
Ward Creek	7,000		42.21	
Pages Meadows	7,000	2	25.00	17.21
Tahoe City	6,230	approx. 4	20.88	4.12

The Transport of Fallen Snow—The phenomenon of transport of snow by wind is disposed of by saying it does not exist—that is, between one basin and another. The snow travels with the utmost readiness up slope and down, but, like the waves of the sea, the same snowflake is not long involved. Irregularities in the topography and forestation quickly impede the wind and allow the snow to sink to rest. Only when the seasonal snowfall is sufficiently heavy to bury or reduce the height of these barriers, will their effect be removed. Finally, every square mile of mountain basin usually has sufficient barriers to prevent more than a small proportion of its snow cover from passing beyond its area. However, as Mr. Horton points out, exceptions may occur, on the open prairie, or in polar regions.

This fact was carefully tested by the senior writer in a series of measurements to determine the value of mountains and forests in conserving snow (*Scientific American Supplement*, Sept. 7, 1912, and reports). On the wind-swept summit of Mount Rose (9,000 to 10,800 ft.) exist buttresses, open slopes, timberline forests and timber screens, and the snow cover in consequence varies normally from nothing to 18 ft. in depth. Yet the average of the snow cover of this restricted area of 1 sq.mi., as shown by 195 measurements of water content, is 26.56 in. This compares closely with the snow cover in protected areas north and south: Crystal Peak, 20.85 in.; Big Meadows, 21.15 in.; Marlette Lake, 22.84 in.

The relative power of these elements in checking the snow movement is shown in the following series, in which the amount of snow held in check by each type of slope is given in terms of water content:

	Water In.
1. Steep Slope (gradient approx. 25 per cent)	
(a) Unforested talus slope	
(1) Below buttresses	25.1
(2) Wind-swept slope	2.6
(3) Slope in lee of peak	35.1
(b) Forested slope	41.1
2. Moderate slope (gradient 15 per cent)	
(a) Talus slope covered with low scrub	13.4
(b) Talus slope slightly steeper than preceding and dotted with screens of timber 10 to 20 feet high	26.5
3. In lee of timber screen on lip of canyon	48.9
Check: Average for entire area	26.6

That the snow does not travel far beyond such barriers is shown by the following measurements of water content of snow cover in Donner Pass (Summit Station):

	In.
Course 1. Crest of pass-timber and open (10 meas.)	43.75
Course 2. Lee of crest, thin forest (22 meas.)	45.30
Course 3. Meadow farther east (28 meas.)	44.87

The fact that the snow cover on the Continental Divide is even shallower than on the Sierra Nevada is conclusive proof of the ability of the mountain and forest barriers there to retain it.

V. *Instrument Errors: Deficiency in Catch*—The deficiency in the catch of snow by the open 8-in. rain gage even in the more level East has been experimentally determined by Mr. Horton to be as great as 14 per cent ("Determination of Mean Precipitation on a Drainage Basin," pp. 13-16). At Wagon Wheel Gap Experiment Station, where the utmost care is used to obtain accurate measurements, the deficiency does not exceed 5 per cent. However, such accuracy can scarcely be maintained at mountain stations dependent upon co-operative or part-time observers. The "roof-effect" suggested by Horton, wherein the angle of the wind to the slope decreases the catch in the gage, may still further increase the disparity between the measured runoff and the measured precipitation. However, on unprotected slopes, silting of the gages by spin-drift snow may counterbalance loss by variation in angle of wind.

Inclination of Slope—Fortunately for the comparison of precipitation with runoff, all areas are computed and mapped by engineers in horizontal projection and thus correspond to the vertical fall of rain and the vertical position in which the snow sampler is held in determining the depth and water content of the snow after it has sunk to rest. Only in the measurement of falling snow, which rides on the wind, is the comparison distorted by the vagaries of local currents. This situation is entirely avoided by snow surveying, which measures the average of the snow cover over considerable distances after the snow has sunk to rest and thus avoids local error.

VI. *Precipitation Over Wide Areas and Locally*—Precipitation at similar elevations or on similar slopes is fairly uniform over wide distances, even 100 miles, along the crest of the range, as shown in the following snow surveys in the Sierra Nevada along both the main range and the Carson Range to the east:

INCHES OF WATER CONTENT, SOUTH TO NORTH

Main Range (total distance between courses 100 miles): Center Mountain, 36.08; Blue Lakes, 39.24; Lake Lucille, 47.81; Rubicon Peak, 43.45; Ward Creek, 42.21; Summit Station, 41.76; Webber Peak, 44.51.

Carson Range (total distance between courses 30 miles): Marlette Lake, 22.84; Mount Rose, 26.56; Big Meadows, 21.15; Crystal Peak, 20.85.

At leeward base of both ranges considerable variation from expected uniformity occurs. All measurements for 1914-15 only:

Base of Main Range (total distance between courses 16 miles): Tallac, 8.4; Rubicon Peak, 12.9; McKinney, 18.4; Tahoe City, 15.0.

Base of Carson Range (total distance between stations 25

miles): Lewer's Ranch, 7.67 in. (U. S. W. B.); Reno, 4.0 (U. S. W. B.).

Normals (Nov.-March) for Reno and Lewer's Ranch give far greater disparity, being 5.61 and 19.26 in. respectively. Variation is accentuated somewhat by greater elevation of Lewer's Ranch and its nearness to Lake Tahoe.

A similar uniformity with diversity appears also on the Continental Divide, though probably accentuated by the greater complexity of the mountain chains. This is indicated by the crest measurements (U. S. W. B.) of precipitation from southwest to northeast; as: Cumbres Pass, 39.29 in.; Silverton, 32.65 in.; and Climax, 36.11 in. Long's Peak (45.99 in.), still farther to the north, may be benefited by its location toward the northern storm track or the absence of near barrier ranges to the west. However, the annual precipitation of 21.55 in. at Wagon Wheel Gap (average elevation of gages 9,967 ft.), also in southwestern Colorado but on the eastern slope of the divide, considerably exceeds the east slope measurements of 14.57 in. and 15.20 in. at Alma (10,228 ft.) and Como (9,785 ft.) near Climax. This may be due to the greater accuracy of the measurements at Wagon Wheel Gap. However, the high percentage of summer precipitation at the stations compared, which must necessarily be in the form of rain or wet snow, indicates a greater degree of accuracy than where the bulk of the precipitation is winter snow.

The increase in precipitation per 1,000 ft. will naturally vary with the base station used in the average. However, on the western slope the variation from south to north, using Climax as the apex, is only 0.5 in. per 1,000 ft., the lines from Rico, Grand Junction and Lay to Climax representing 4.2, 3.7, and 3.9 in. per 1,000 ft. respectively. On the eastern slope, the increase per 1,000 ft. from Colorado Springs to Climax is 4.2 in. However, from Colorado Springs to the summit of Pikes Peak, upon which Horton apparently bases his curve for the eastern slope, the increase is only 1.9 in., or from Colorado Springs to Moraine Lake, 2.6 in. per 1,000 ft. Far to the north at Long's Peak, where the precipitation is extremely heavy, the increase, as pointed out by Follansbee, reaches 8.1 in. per 1,000 ft. However, as will be seen in Table II, in the high basins near the crest of the divide, the increase with elevation is 5 to 8.5 in. for each 1,000 ft. on the western slope and 5 to 20 in. on the eastern. Consequently, in determining the local precipitation the general rate of increase for the range as a whole will not apply.

VII. *Adjusted Precipitation and Runoff*—In the recomparison of adjusted precipitation measurements and measured runoff, three adjustments in the data are advisable.

1. Since experience in the Sierra Nevada indicates that not more than 10 per cent of the July-October precipitation finds its way into the streams, some reduction should be made in the quantitative precipitation with which the runoff is being compared. A preferable method would be the comparison of the major runoff, which occurs during April-July and which includes 66 to 75 per cent of the total annual flow, with the winter precipitation of November-March which directly causes it. To this precipitation should be added the precipitation for April-June, for it falls mainly upon snowfields, especially on the northern slopes, and directly augments their snow storage.

However, since stream-flow data are available for only a portion of the streams, the annual runoff has been kept unchanged and the November-June precipitation has been increased by 50 per cent of the precipitation from July to October. The increase from 10 per cent, the assumed effective factor of precipitation in the Sierra Nevada, to 50 per cent on the Continental Divide, is due to the fact that the basins under consideration are near the mountain crest, where the soil is thin and absorption by the soil is less, and especially to the fact that the rains are much more frequent or more intense than in the Sierra.

2. Most of the basins on the eastern slope adjoin the crest, and consequently receive on the immediate lee of the crest considerable precipitation only slightly less intense than that in the corresponding basins on the western slope. This fact will necessarily presuppose a slightly greater precipitation for these basins than is represented by the precipitation at similar altitudes but farther to leeward. Basins on the western slope, if in the lee of dominating crests, probably receive similar accretions. However, this gain is insignificant as compared with the heavier loss caused by this same barrier ridge in condensing on its windward slope much of the precipitation that would otherwise fall in the basins.

TABLE III—INCREASE IN PRECIPITATION WITH ELEVATION

Including Key Stations, Difference in Elevation, and Distance Apart. (Based on efficient precipitation: Nov.-June plus 50 per cent of July-Oct.)

Key Stations	South to North: Difference in Elevation Ft.	South to North: Distance Apart Miles	Difference in Precipitation per 1,000 Ft. In.
Western slope			
Base-crest			
Lay-Climax	5,114	124.0	4.2
Near crest			
Ashcroft-Climax	1,821	42.5(along range)	8.5
Breckenridge-Climax	1,948	11.0	5.0
Eastern slope			
Near-crest			
Climax-Alma	1,076	11.0	20.6
Climax-Leadville	1,056	10.0	19.8
Climax-Como	1,519	17.5	13.3
Climax-Idaho Springs	3,748	47.5(along range)	5.0

3. Owing to local differences already noted in the rate of increase in precipitation with elevation, the rate of increase for each basin or group of related basins should be determined so far as possible from adjacent precipitation stations. The adjustment factors for precipitation are given in Table III.

In Table IV the arrangement of basins follows Follansbee and Horton except for division into organic groups and rearrangement from southwest to north and by western and eastern slopes. The approximate mean elevation after Horton is given and also the relative area above 10,000, 11,000, 12,000 and 13,000 ft. is repeated from Follansbee (U. S. G. S. Water Supply Paper 500, p. 67) to indicate the effect of altitude on precipitation.

A fair degree of uniformity between runoff and adjusted precipitation seems to prevail throughout the series, the losses varying ordinarily from 25 to 50 per cent, except in the case of H.6, Maroon Creek, where the loss falls to 13.8 per cent and of its neighbor H.5, Crystal River, where an excess of 31.7 per cent prevails. Because of its situation within 15 miles of Ashcroft, on whose precipitation the adjusted precipitation for the group was based, the only tenable explanation is topography, as in the case of the intense precipitation at McKinney's on Lake Tahoe at the eastern base of the main Sierra and in Washoe Valley at the eastern base of the Carson Range. This is the explanation given by Follansbee for the intense precipitation in Crystal River, who states that "west of the mountain

range whose eastern slope is drained by Crystal River there are no other mountain masses higher than the flat-topped mesas of western Colorado." This effect extends to Maroon Creek, which is buried deeper in the Continental Divide.

Another example of excessive runoff is found in H.18, Fraser River, and H.21, South Boulder Creek, which drain opposite sides of the same crest. The former, a west slope stream, represents a gain of approximately 8 in. depth over that of the nearest basin to the south in the series. The latter, an east slope stream, is about 13 in. above the corresponding east slope basin to the south. The loss of adjusted precipitation at Idaho Springs is only 21 per cent, though the precipitation there is higher than at other neighboring stations to the south. The same cause, which finds its greatest effectiveness in South Boulder Creek, probably applies to Fraser River on the west and to the district around Idaho Springs to the south. Follansbee explains this also "by the fact that west of this part of the divide lies the comparatively open region of Middle Park, and west of that no mountain masses as high as the divide itself."

VIII. *Probable Correction Factor for Water Losses*—The small loss between precipitation and runoff is justly the subject of remark by Horton, who uses the losses of 15.43 in. or 71.6 per cent at Wagon Wheel Gap as a standard of comparison. However, this loss seems too high as a general average for the region when compared with the loss of 25.1 per cent at Sand Lake, Wyoming (*Engineering and Contracting*, Aug. 30, 1916, p. 189).

Fortunately, the disparity in general features between the two basins is not great. Sand Lake is a tiny drainage area of 3.01 sq.mi. situated in Wyoming at 10,120 to 10,800 ft. elevation, where parks and timber bear the area-relationship of 8:10, the timber consisting mainly of lodgepole pine and spruce. The "soil is sandy, with a good percentage of clay, and appears to be underlain with bedrock at a depth of 6 to 8 feet." Here in the two seasons of 1915-17, when great care was taken to attain precision in the snow surveys, the loss between the measured snow cover

TABLE IV—COMPARISON OF RUNOFF IN HIGH LEVEL BASINS OF CONTINENTAL DIVIDE WITH PRECIPITATION AT ADJACENT U. S. WEATHER BUREAU STATIONS ADJUSTED FOR EFFICIENCY IN PRODUCING RUNOFF AND FOR ELEVATION OF BASIN

Basins are arranged from S.W. to N. along Divide but by Organic Groups and Situation on Its Western and Eastern Slope. Within the Organic Groups the arrangement is by relative amount of area at higher elevations to facilitate using Horton's Map (*Eng. News-Record*, Feb. 28, 1924, p. 356 Fig. 1), Horton's numbers for the Individual Basin are used, viz. H_1, H_2.

	Individual Basins	Location in Colorado	Area Sq. Mi.	Elevation of Basin: Approx. Mean Elevation	Per Cent of Area Above 10,000 Ft.	Per Cent of Area Above 11,000 Ft.	Per Cent of Area Above 12,000 Ft.	Per Cent of Area Above 13,000 Ft.	Runoff Per Sq. Mile Acre-Ft.	Runoff Per Sq. Mile In. Depth	Adjacent U. S. Weather Bureau Stations: Stations	Elevation	Precipitation (Inches): Annual	Efficient for Runoff	Adjusted for Elev. of Basin (Correction Factor Western Slope 5 in. per 1,000 ft.)	Loss Between Adjusted Precipitation and Runoff: Inches	Per Cent	Remarks
I. *Western or windward slope*																		
Group 1	H.3 Canyon Creek	Ouray	26	10,050	86	69	35	7	1,780	33.37	Silverton	9,283	32.65	27.57	(2½x5) 40.07	−6.70	16.7	
	H.2 Uncompahgre River	Below Ouray	76	10,385	88	66	32	4	1,670	31.31						−8.76	21.9	
	H.3 Uncompahgre River	Ouray	44	10,500	88	66	28	2	1,360	25.50						−14.57	36.4	
2	H.5 Crystal River	Marble	77	10,210	78	52	26	3	2,340	43.87	Ashcroft	9,483	19.84	16.31	(2x8.5) 33.31[1]	+10.56	+31.7	[1] Applies especially to Castle Creek in whose basin it is.
	H.6 Maroon Creek	Near Aspen	42	10,205	79	43	21	2	1,530	28.69						−4.62	13.9	
	H.7 Castle Creek	Near Aspen	62	10,692	82	57	18	1.5	1,240	23.26						−10.05	30.2	
	H.8 Roaring Fork	Aspen	109	10,090	80	46	18	3	1,260	24.00						−9.31	27.9	
	H.9 Frying Pan Creek	Thomasville	174	9,785	70	39	11	2	1,090	20.44						−12.87	38.6	
3	H.10 Homestake Creek	Redcliff	64	10,405	63	47	12	1	1,210	22.69	Gillman	8,500	19.70	16.62	(2½x5) 29.12	−6.43	22.1	
	H.11 Turkey Creek	Redcliff	27	9,485	30	8	0	0	944	17.70					(1x5) 21.62	−3.92	18.1	
4	H.16 Snake River	Dillon	92	10,740	81	48	17	1	792	14.86	Breckenridge	9,356	25.48	21.81	(1.5x5) 29.31	−14.45	49.3	
	H.17 Ten Mile Creek	Dillon	113	10,420	61	41	6	0	985	18.47	Climax	11,304	36.11	31.68	(−0.9x5) 27.18	−8.71	32.0	
5	H.18 Fraser River	Near Arrow	28	11,165	90		21	0	1,400	26.25								
II. *Eastern or leeward slope*											(Correction Factor Eastern Slope 5 to 20 in. per 1,000 ft.)							
Group 6	H.4 Rio Grande	Thirty Mile Bridge	163	11,360	95	77	39	2	1,090	20.44	Wagon Wheel Gap	9,967	21.0	19.0 est.	(1.5x20) 44.0	−23.56	53.5	
7	H.15 Chalk Creek	Near St. Elmo	48	10,935	99	74	30	4	767	14.38	White Pine	9,500	11.61	9.61 est.	(1.5x20) 39.61	−25.23	63.7	
8	H.14 Halfmoon Creek	Near Leadville	26	10,707	92	58	27	4.5	877	16.44	Leadville	10,248	13.94	11.90	(0.6x20) 23.90	−7.46	31.2	
	H.13 E. Fork Arkansas	Near Leadville	52	10,955	95	65	23	3	595	11.14					(0.7x20) 25.90	−14.76	57.0	
	H.12 Tennessee Fork	Near Leadville	45	10,460	64	23	9	0	623	11.68					(0.2x20) 15.90	−4.22	26.5	
9	H.19 Geneva Creek	Grant	74	10,740	87	56	28	3	718	13.46	Como	9,785	15.20	11.46	(1x13) 24.46[2]	−11.00	45.0	[2] The precipitation at lower elevations seems to be increasingly heavy with distance north.
	H.20 N. Fork South Platte	Grant	51	9,850	69	34	8	0	470	8.81					(0.5x13) 17.96[2]	−9.15	50.9	
10	H.21 South Boulder Creek	Rollinsville	39	9,700	62	33	2	0	1,180	22.13	Idaho Springs	7,556	16.61	13.01	(3x5) 28.01[2]	−5.88	21.0	
11	Check Basin for Eastern Slope Wagon Wheel Gap	Wagon Wheel Gap	0.66	10,000 est.	50	3	0	0		6.12	Wagon Wheel Gap	9,967	21.55	16.47	(0x5) 16.47	−10.35	62.8	

plus the rainfall through September and the resulting runoff was only 12.9 per cent. Or, if the measured snow cover is increased by 51 in. to adjust it for interception and evaporation losses during the winter, the loss is increased to 25.1 per cent. On the other hand, the annual precipitation at Wagon Wheel Gap should be adjusted from 21.55 in. to 16.47 in., which represents more nearly the efficient precipitation at that place and corresponds more closely to the adjusted snow cover and summer precipitation at Sand Lake.

In this case, the comparison is as follows: Loss at Wagon Wheel Gap, 62.8 per cent; at Sand Lake, 25.1 per cent. However, the apparent disparity is considerably decreased by the fact that both the snow cover and the total efficient precipitation at Sand Lake are approximately 50 per cent higher than at Wagon Wheel Gap, the adjusted snow cover and summer precipitation at the former being approximately 30 in., as compared with 16.47 in. at the latter. Or to substitute absolute for relative loss, the loss between efficient precipitation and runoff at Sand Lake is approximately 7.5 in. as compared with 10.35 in. at Wagon Wheel Gap.

The general similarity of the adjusted precipitation at Sand Lake and in most of the basins discussed increases the probability that the small losses noted there are roughly correct. The forestation at their elevation also resembles that at Sand Lake in consisting of conifers and open slopes, the open slopes, however, being at a higher elevation than at Sand Lake and covered with grass.

The advantage of relatively thin soil and talus slopes with increasing elevation is probably offset by increasing wind movement, the former decreasing the absorption losses by the soil, the latter causing increased evaporation. Another factor of increasing effectiveness with elevation is the inevitable increase in humidity, with corresponding decrease in evaporation, as the elevation of maximum precipitation is approached.

However, the loss at Wagon Wheel Gap is paralleled by a similar loss at nearly 2,000 ft. higher elevation on the eastern slope of Pikes Peak, where the soil should be shallow and the forest cover thin. The basin in point is Boehmer Creek, whose loss between gross annual precipitation and annual runoff is 14.77 in., or between the efficient precipitation and the runoff approximately 10 in. Other basins adjoining Boehmer Creek show similar losses. Even if this higher estimate of loss is adopted and a loss of 10 in. instead of 7.5 in. is considered the normal standard, of the twenty streams for which precipitation measurements are available ten are at or above normal and four more only slightly below and of the nine groups of basins concerned, all but two have one or more basins that are normal.

Since these variations occur even within groups of basins where only a single precipitation station is used as the standard of comparison, it is evident that the diversity is due not to instrumental error but to topography. This is particularly true in the case of Crystal River, where even a heavy upward correction for instrumental error would be insufficient to produce precipitation measurements comparable to the runoff. It is likewise true in the Rio Grande (H.4) and Chalk Creek (H.15) basins, where the adjusted precipitation exceeds the runoff by 23 to 25 inches.

IX. *Value of Snow Surveying*—A few representative snow courses in the doubtful basins would probably solve the problem and yield much data of scientific interest. However, the practical solution of the problem of precipitation and runoff does not lie in applying quantative measurements of precipitation to areas, which involves corrections for losses not readily measured, but in determining the seasonal percentage of the snow cover and using this percentage as indicative of the subsequent major runoff of the dependent streams. Since the seasonal percentage of the snow cover is fairly uniform over large areas, a few representative snow courses even on the complex Continental Divide should suffice.

Discussion of Snow Surveying From an Engineer's Standpoint

By H. E. Boardman

When the wind is blowing, falling snow travels in an inclined direction and it is unreasonable to expect to get a catch in any sort of a pan which will represent the correct precipitation, and the wind very frequently blows during snowstorms in the mountains.

To repeat briefly, for the benefit of those who have not read former articles on the subject, the Church method is as follows: Snow survey courses are laid out in carefully selected locations where measurements of vertical depth and water content are made with steel tubes which bring up cores. The tube with core is weighed on scales which indicate equivalent inches of depth of water, the pointer on the scales having been set at zero with the balanced empty tube before taking the measurement. These measurements are taken at regular intervals along the course sometimes every 50 ft. and sometimes every 100 ft., the courses often being several thousand feet long. These courses are marked by blazes on trees or other landmarks and descriptions are recorded and measurements made year after year along the same courses and at the same spots, with measurements by tape between sounding points.

These snow measurements are made about the end of March after practically all of the snowfall for the season has taken place and before much of it has melted and run off. I fail to see how any other method now practiced can be expected to give assurance of as close an approximation of total winter precipitation as this method. By comparing the results with runoff from the same and neighboring similar watersheds, normals are established in runoff and in winter precipitation on these snow courses. Then the different years are classified in percentage of normal. By determining from these snow surveys what per cent of normal the winter precipitation has been it is possible to predict approximately what runoff to expect, some time before it happens. A few measurements made at various times during the winter also show whether the snowfall is ahead of or behind normal schedule.

Various factors, such as temperature, spring rainfall, condition of the ground when first covered with snow, etc., affect the predictions and add to the interest of the problem. Some of these factors would be quite different in the Colorado mountains from what they are in the Sierras. Several of the power companies in the Sierras are co-operating in this work and others have expressed great interest in it, and will probably take an active part later on.

Technical Features of Annual Am. Soc. C. E. Meeting

Report of Discussion at Five Technical Divisions on Highways, City Planning, Sanitation, Power and Structures and Abstract of Action on Technical Committee Reports

TWO full afternoons of the annual meeting of the American Society of Civil Engineers at New York, Jan. 21-23, were devoted to discussion of the technical matters which are reported herewith.

Sanitary Division

The single topic for technical discussion by the Sanitary Division was control of obnoxious odors, to which the whole of two sessions was devoted. The law of the subject was clearly and entertainingly outlined by Irving I. Goldsmith, deputy attorney general, State of New York, and Joseph A. Warren, an attorney of New York City who was formerly counsel for the New York State Department of Health. Among other things, Mr. Goldsmith pointed out the growing tendency of state legislatures to intrust the control of nuisances to administrative departments of government instead of vesting relief wholly in the courts. In much earlier days than the present the control of nuisances was recognized in law only as for the protection of property whereas now it is considered very largely a matter of public health and comfort.

A paper on methods of determining the source and extent of obnoxious odors was presented by Stephen DeM. Gage, chief chemist and sanitary engineer, Rhode Island State Board of Health, and discussed by C. A. Holmquist, director, Division of Sanitation, New York State Department of Health. An odor investigation, said Mr. Gage, may be divided into five parts: Origin and cause; range of influence; effect on health; property damage; remedies. As yet there is no generally accepted unit for recording the intensity of objectionable odors. Mr. Holmquist suggested that odor control might well be made the subject of study by a commission of the division. In the general discussion of this paper the variety of odors that may require investigation by engineers and health officers was brought out by George H. Shaw, chief, Division of Housing and Sanitation, Philadelphia Department of Health, who mentioned the following odor nuisances in Philadelphia: Those arising from the manufacture of red oxide paint; rendering works; oil refineries; a plant manufacturing electric batteries. Plant and method improvements brought about through the agency of engineers have done much to eliminate the causes for complaints at these various establishments. L. L. Tribus, consulting engineer, New York City, remarked that he felt like a public benefactor in view of the discussions that have followed the presentation of a paper by him before the society two years ago on "Odors and Their Travel Habits."

Odors from garbage disposal plants was formally presented in written papers by Samuel A. Greeley, consulting engineer, Chicago; John V. Lewis, sanitary engineer, Board of Public Works, Rochester; and I. S. Osborn, vise-president, The C. O. Bartlett & Snow Co., Cleveland.

Sewage-works odors were taken up, first of all, by John F. Skinner, deputy city engineer of Rochester. Mr. Skinner stated that sewage-works should not be overloaded, should be located in a protected and isolated spot, should be operated "to avoid uncovered, decomposing, solid matter," and that the "walls and floors should be kept washed down clean at least daily." Screening the plant by trees and shrubbery is desirable. A search by engineers for "some type of gaseous disinfection which would be pleasant, or, better still, odorless," and the devising of some means for the economical application of such a disinfectant were suggested as profitable lines of research for engineers. Morris Cohen, superintendent of sewage disposal, Schenectady, N. Y., told of complaints and lawsuits following closely after the operation of sewage-works there in 1915 and outlined remedial measures. Since the latter were applied there have been no complaints against the plant. A lengthy paper on "The Detection and Elimination of Odors from Oil Refineries" was presented in abstract by R. S. Weston, consulting engineer, Boston.

City Planning Division

With about 40 members in attendance, the City Planning Division, Edwin A. Fisher, presiding, opened its session, Jan. 22, with the announcement of the election of an executive committee consisting of Charles B. Ball, Harland Bartholomew, Frederic H. Fay, Edwin A. Fisher, and Morris Knowles. In the first paper, on the scope of city planning, Allen J. Saville, Richmond, Va., discussed measures of prevention and of cure. He pointed out that proper planning of a street system reduces grading costs and emphasized the need of bypass routes to carry motor vehicle traffic around, instead of through, important cities. In the discussion by J. C. Carpenter it was brought out that streets constitute from 20 to 40 per cent of the total area of a city and should be the first consideration of the city planner.

W. W. Horner devoted his remarks to the administrative phase of the subject. The mere plan, said Mr. Horner, is not enough unless provision is made for adherence to it through some form of continuing administration. Capt. George H. Norton told of the progress made in regional planning by co-operative effort in the vicinity of Buffalo. One of the most urgent needs, according to Frank B. Williams, is legislation to bring to realization city plans which often never pass the stage of neatly lettered drawings. In Masschusetts, according to Frederic H. Fay, there has been in operation for about two years a Metropolitan Planning Division which concerns itself with problems of the district adjacent to Boston. Mr. Fay predicted that highway traffic is destined to become a more important element of city planning than in the past and cited the case of the Boston & Maine R.R., which has applied for permission to abandon a considerable mileage of its tracks and substitute therefor routes for freight-carrying motor trucks and passenger-carrying buses.

Necessity for inclusion of facilities for air transport in future city plans was forecast by T. H. Skinner. The time is not far distant, he said, when all important cities must have landing fields for both airplanes and dirigibles. With regard to traffic on city streets, Col.

W. G. Atwood made the point that congestion can increase only up to a certain point, beyond which there results a great economic loss.

At the afternoon session the program provided for papers on excess condemnation by Frank B. Williams, Frederic H. Fay, Arthur L. Vedder, and Charles W. Leavitt.

Structural Division

Organization of the new Structural Division of the society brought together a more active group than did the meetings of some of the established divisions. More than 80 attended. Prof. C. T. Bishop presiding, a constitution was adopted and an executive committee elected for the coming year, consisting of H. C. Baird, C. T. Bishop, C. E. Chase, W. G. Grove, and C. F. Loweth. Animated discussion developed over whether "structural engineering" as mentioned in the constitution of the division is to be interpreted broadly as applying to all materials and all types of structure, or more narrowly. The decision was strongly in favor of the broad interpretation.

An ambitious undertaking was proposed by Eugene W. Stern, who moved the appointment of a committee of seven to prepare specifications for and recommend proper practices in the structural design of buildings. Several members opposed the purpose of the motion partly on the ground of its doubtful utility and partly because of the vast labor involved; and it was finally referred to the executive committee.

Provision is made in the constitution of the division for local meetings, and the subject was discussed somewhat; for the present no such meetings are planned.

Power Division

The meeting of the Power Division was devoted to a discussion of the high specific speed turbines, and included a report on foreign turbines of this type by George A. Orrok, on the propeller type by Lewis F. Moody, on high-speed suction turbines by Forrest Nagler, on the relative efficiencies of different size propeller wheels by George A. Jessop, and on the engineering considerations in proportioning units in low-head plants by John P. Hogan. The whole trend of the papers and the discussions showed the growing utility of the high-speed propeller type turbine for low-head plants. It was several times stated that 30-ft. head seems at present to be the limit of utility of this type of wheel, but, as Mr. Hogan said, "the result of its use is an increase in the speed of the wheel and the generator for a given quantity of water, a consequent decrease in cost of wheel and generator, or a decrease in the number of units, all resulting in power-house savings. A normal propeller wheel operating on a 30-ft. head will probably take 4,000 sec.-ft. of water at 85 revolutions per min. and would therefore be roughly equivalent to the 2,000-sec.-ft. Francis wheel operating at the same speed, although the propeller wheel will develop nearly twice the power." A secondary point brought out is that the governors are becoming less and less a factor in the power-plant design, particularly in that in which propeller wheels are used, because, first, of the interconnection developments which are taking place, and, secondly, because of a large number of wheels which are being installed in plants, particularly in low-head plants, permitting regulation in low-water stages by concentrating the flow in fewer turbines, each running at full capacity. "It is believed," said Mr. Nagler, "that this feature of variable capacity will be utilized not so much for its advantages in increasing part-load efficiency as for the possibility it presents in increasing capacity under conditions of flood or low head."

E. P. Hamilton, of the Engineering Staff of Proprietors of Locks and Canals on the Merrimac River, and Mr. Nagler, of the Allis-Chalmers Co., had a discussion as to the priority in invention in the matter of the propeller type turbine, Mr. Hamilton contending that the old Truax wheel of 1870 was the forerunner of the propeller type wheel that Mr. Nagler devised some 12 years ago. The discussion, however, was not carried beyond the presentation of each side of the case.

Highway Division

At the session of the Highway Division a paper on development of highway traffic was read by Prof. A. N. Johnson and discussed by W. H. Connell, T. R. Agg and A. W. Dean. Professor Johnson concluded that the largest possible expansion that may be reasonably expected in motor traffic, assuming 75 per cent of the total traffic to be placed on only 10 per cent of the roads, is an average daily traffic of 1,500 vehicles per hour, which is a little more than one-third the capacity of a two-track road.

With the highway systems built two lanes wide, supplemented by an increasing mileage of improved side roads, as well as extensions to the state roads themselves, it is not reasonable to expect there will occur for many years to come any general congestion of traffic. Congestion, however, will continue increasingly to occur at certain points where traffic tends to concentrate, until the forces which attract traffic to these centers cease to act. It may well be that the very congestion itself will cause such a point to be no longer a center of attraction. The traffic will stifle the very thing which attracts it. This is happening and will happen again unless means can be found to prevent continued congestion, by additional roads, wider roads, and streets, the dispersion of certain business activities, and, in general, giving a greater area for the traffic to be accommodated. On the whole, however, engineers are proceeding wisely and sufficiently in the design of the larger proportion of the mileage of improved roads if a two-lane width is provided.

In discussion W. N. Connell, emphasizing the importance of traffic surveys in planning roads, said: Prior to the traffic studies made in Pennsylvania, both the engineers in the department and the public had a greatly exaggerated idea of the amount and weight of truck traffic. It has developed that this traffic amounts to about ten per cent of the total traffic and about 22 per cent of the total tonnage on the highways. The heavy truck traffic (loads over 18,000 lb.) amounts to 5 per cent of the truck traffic and, therefore, only 0.5 per cent of the total traffic. The heaviest truck traffic (loads over 24,000 lb.) amounts to about 1.0 per cent of the truck traffic and, therefore, only 0.1 per cent of the total traffic. The truck traffic will, of course, increase but it will not take the place of the railroads as transportation of great quantities for long distances will always be more economically handled by freight

trains. The heavier trucks, however, will greatly increase in the terminal areas near the large centers of population as they are being used more and more by the railroads, particularly for hauling less than carload lots.

The results of the survey indicate that 92 per cent of the traffic is local and 8 per cent through traffic. Eighty-five per cent of the traffic consists of Pennsylvania cars and 15 per cent foreign cars. Foreign cars constitute part of the local traffic in the counties bordering the adjoining states; a traffic count of these counties shows 75 per cent Pennsylvania cars and 25 per cent foreign cars. The traffic count of the counties in the central section of the state shows 96 per cent Pennsylvania cars and only 4 per cent foreign cars. This 4 per cent constitutes the tourists. The indications are that of the passenger travel, from 30 to 40 per cent can be considered as business travel.

Movement in Concrete—Prof. W. K. Hatt, Purdue University, delivered a paper entitled "The Effect of Moisture on Concrete," which reported an investigation conducted at Purdue in co-operation with the Bureau of Public Roads to measure the maximum warping and surface deformation produced in a concrete road slab as the result of a non-uniform distribution of moisture. The tests also yielded data on the expansion and contraction of concrete useful in the design of concrete structures. The paper was accompanied by a review of the literature on the measurement of volume changes in portland cement and concrete.

As a result of the studies, the author reached conclusions which can be abstracted as follows: Strength of concrete, like that of wood, varies in moisture content. The saturated concrete will have 80 to 85 per cent the strength of dry concrete. The thermal coefficient of the strength of concrete varies from 0.000004 at 65 deg. F. to 0.000006 at 140 deg. F. Concrete expands when immersed in water and contracts on drying, the degree of change varying with various characteristics. Concrete road slabs warp upward at the corners and the edges when the surface becomes dry and when the bottom absorbs moisture from the subgrade, maximum deflections being 0.02 in. at the corners and 0.20 in. due to subgrade moisture. A combination of shrinkage from drying and from a fall in temperature will produce maximum shrinkage strains. Curing concrete will tend to reduce the shrinkage strains and consequently cracks.

In the discussion the importance of the observations was confirmed but the need for more complete studies emphasized.

The division's proceedings were completed by discussions on the necessity for research in highway work and on the Hubbard test for grading asphalt mixtures to insure stability.

Technical Committee Reports

Most of the technical committees of the society reported, several presenting extensive results. A report on continued investigation of railroad track stresses was presented by Prof. A. N. Talbot, chairman of the joint committee which has been dealing with this subject for half a dozen years; an elaborate report on working stresses for structural steel in buildings was submitted by a committee headed by Prof. F. O. Dufour; and the work done by the joint conference on standard construction contracts last year was reported *in extenso* by the society's committee, headed by J. S. Langthorn. The most elaborate of these, the track stress report, unfortunately is not available for summary here, as it is still in manuscript form and was presented only through a brief statement indicating in a general way the nature of the work done in its preparation.

Steel Working Stresses—After two years' study of its subject, the Committee on Stresses in Structural Steel presented a final report. It says that present practice in working stresses for structural steel in buildings, which is based on a 16,000-lb. working stress, is uneconomical and inefficient, and that higher stresses are warranted. After examination of the quality of commercial structural steel, consideration of service experience with steel structures during the last thirty years or more, and a study of service requirements, the committee concludes that a yield-point value of 30,000 lb. per square inch may be taken as the datum point of the strength of commercial steel, and that a 50 per cent strength margin above the total normal load effect provides an adequate reserve of strength on condition that competent design and first-class workmanship are obtained. It proposes the following working stresses, to be applied to equivalent static stress: Tension, 20,000 lb. per sq.in.; bending, 20,000 lb. when the compression flange is continuously supported laterally, and under other conditions a stress given by the formula $20{,}000 - 200l/b$ for ratio of unsupported length to flange width above 10, and a value of 18,000 for ratios below 10; column compression, 16,000 up to length ratio $l/r = 50$, and for higher length ratios a stress given by the formula $16{,}000 - 80E$, where E is the excess of length ratio over 50; web shear on net section, 15,000; rivet and bolt shear, 15,000 and 10,000; rivet bearing, 18,000 to 30,000, depending on whether the rivets are hand or power driven and on whether they are in single shear or in double shear.

A minority report favored working stresses of 18,000 lb. for tension and bending, and 15,000 maximum for column compression. This recommendation was based on the opinion that while present working stresses are unduly low, only a moderate increase should be made until many questions about steel and about methods of test and fabrication and the stress conditions within structures have been investigated more fully. The entire committee, without division of opinion, reported in favor of the society's undertaking a series of strain measurements on structures, to give more ample data on the relation between calculated and observed stresses and upon the action of different types of structure.

Much support was given to the majority's recommendations, by the discussion. Dr. D. B. Steinman endorsed the recommendations and expressed the view that present practice is empirical and arbitrary. Prof. C. T. Morris stated that the study of working stresses in steel which was carried out in connection with reconstruction of the Niagara railway arch bridge six years ago, as reported to the society in a paper by C. E. Fowler, led to the decision to use unit stresses similar to those now recommended for building work. He has recently approved the use of 18,000 lb. for a 35-story building frame, contingent on careful checking of the design. Prof. M. S. Ketchum, who two years ago served on a board of engineers employed by the steel fabricators' organization (American Institute of Steel Construction) to recommend working stresses,

stated that he had at that time favored adoption of 20,000 lb. per sq.in. as basic working stress (the board actually recommended 18,000 lb.). He expressed much gratification at finding that the report of the present committee confirms his own previous judgment, and stated that he thinks still higher working stresses may be warranted after some further investigation. Charles Evan Fowler also endorsed the majority recommendations. Shortridge Hardesty quoted figures from practice to show that commercial structural steel ranges above 34,000 lb. in yield-point; he considers working stresses of 18,000 to 20,000 lb. safe, but would like to specify a minimum yield-point of 33,000 rather than the present minimum of 30,000. Dr. J. A. L. Waddell also spoke in favor of higher yield-points, and stated that it is readily possible to obtain steel to a minimum yield-point of 35,000, which he regularly specified and regularly obtained even many years ago.

Impact in Highway Bridges—Work done in 1924 by the committee on impact in highway bridges, as summarized by Prof. A. H. Fuller, chairman, was mainly carried out with a strain-gage of the electric resistance type (Bureau of Standards). The work did not extend the conclusions drawn from the 1923 experiments (see *Engineering News-Record*, Oct. 16, 1924, p. 621). No figures for the 1924 work were given, but the statement was made that "although substantial progress has been made, further field work will be necessary." The committee plans to submit a final report on floor impact next year. It doubts the possibility of obtaining useful data on truss impact until it can make stress measurements on an experimental bridge located elsewhere than on a traveled highway.

Concrete Arches—Experimental work undertaken by the committee more than a year ago, on two large arch bridges at Conneaut, Ohio, and Danville, Ill., has continued during the year, according to the report of Prof. C. T. Morris, chairman. Yield of foundations, distortions of arch rings, deformation of the piers themselves, temperature variation in the concrete, comparison of deformations of the rib concrete and of an unstressed mass of concrete of similar section, and stress measurement in the steel arch centers were included in this work. The Conneaut bridge was opened six months ago, but the distortion measurements will continue during the coming year under traffic. The Danville bridge, which has been in service for several years, is being investigated for traffic and climatic effect. In addition, experimental work is being done to investigate the effect of slenderness ratio of arch ribs, the relation between temperature and moisture expansion, and the strength of skew arches.

Construction Contracts—The special committee on Standard Committee Contracts through its chairman, J. S. Langthorn, submitted a Progress Report which included drafts of the Proposed Standard Contracts for engineering construction and for construction of buildings as issued by the Joint Conference on Standard Construction Contracts in March, 1924. These two standard forms were reported in *Engineering News-Record*, Nov. 13, 1924, p. 796. The report was received by the society.

Mr. Langthorn in answer to a query stated that the committee definitely approved the two contract forms submitted. In its prefatory notes the committee emphasizes the importance of the arbitration clauses in the standard forms. It says "As far as your committee can judge a considerable majority of engineers are in favor of arbitration." The committee brings to the attention of the society the New York Arbitration Law which makes compulsory the completion of arbitration once the two parties of the contract have agreed to its being invoked and provides for the enforcement by law of any decision rendered by an arbitrator under this form of contract. The Arbitration Society of America, which is promoting the development of business arbitration, submitted some alternate clauses for the arbitration in the standard form but these alternates have not as yet been submitted to the Joint Conference.

E. J. Mehren brought to the attention of the meeting the desirability of business arbitration such as is now possible in New York and New Jersey and suggested the appointment of a committee to study the subject. Past-president C. F. Loweth announced that the board at the evening before provided for the appointment of just such a committee.

Irrigation Hydraulics—Nine subjects are under investigation. D. C. Henny, chairman, reported the present status of the work. A comparison of reservoir evaporation and pan evaporation is being carried on at the East Park reservoir of the Orland reclamation project, California. Experiments on the losses in canals at changes of cross-section are being carried out by F. C. Scobey and B. A. Etcheverry; to date it seems that proper shaping of transition sections can practically eliminate loss of head, though the transitions must be quite long in case of decreasing velocity. Water movement and pressure under dams is being studied by A. L. Fellows. Tentative data are in hand concerning losses in siphon spillways, but more experimental work is awaited before a report will be made. Silt deposition in irrigation canals and reservoirs has been studied by F. D. Pyle and Franklin Thomas. Little has been done in the subject of chutes and drops, but field tests on such structures may be undertaken later. The committee has studied Venturi flumes and other devices for measuring irrigation deliveries, but is not yet at the point of reporting finally on this subject. The design of side-channel spillways, an important feature of several water storage dams for irrigation, has been studied theoretically, and plans are being made for getting an experimental check on results. Permissible canal velocities have been studied very fully by Samuel Fortier and F. C. Scobey, and a final report on this part of the subject will probably soon be published.

Flood-Protection Data—Compilation of data has virtually been completed by the committee (N. C. Grover, chairman), and analysis of the data is to be undertaken during the coming year. The committee believes that if it can obtain the necessary funds to do this work in the desired thorough manner, general laws or principles concerning flood probabilities can be derived for different streams or different regions, thus supplying the basis for flood-protection planning in different parts of the country.

Other Committees — The committees on hydraulic phenomena (Prof. S. M. Woodward, chairman) and on steel column research (Prof. F. E. Turneaure, chairman) also outlined their progress and their plans, but these committees are as yet in the preparatory stages of their work.

Bypass Road Problem Important One in Ohio

State Lies Across Main East and West Interstate Travel Routes and Has Many Heavy Traffic Industrial Communities

By G. F. Schlesinger
State Highway Engineer, Columbus, Ohio

THE establishment and improvement of so-called bypass roads around centers of population and traffic distribution is becoming of increasing importance in the state of Ohio. Due to several factors, practically all of the through or interstate traffic between the east and west traverses this state. It is located between the southernmost of the great lakes and the Ohio River and there are no continuous east and west improved roads south of the river. Such well-known transcontinental routes as the National road (Old Trails), Lincoln highway, Chicago-Buffalo route and the Atlantic-Pacific highway cross Ohio and are either completely improved or in process of completion. Due to additional time consumed, traffic congestion, and, in some cases, extra distance involved, it is undesirable and an economic loss to both the user of the road and the cities along the

BYPASS STATE ROADS IN NORTHEASTERN OHIO

route to compel traffic to pass through centers of traffic density.

The system of financing state highway projects in Ohio is a matter of co-operation between the smaller political subdivisions and the state. Neither the improvements completed nor the roads designated as a part of the state system have always been logical from a state-wide or interstate traffic point of view. The state system of highways was established eleven years ago and has been added to since that time. Very few, if any, highway officials anywhere could foresee the remarkable development in motor vehicular traffic that has come about in the last decade. The necessity for bypass roads has only very recently been realized by highway administrators. However, the present state system of Ohio in a number of instances provides for bypass routes.

The northeastern section of the state which is predominatingly industrial with the general trend of traffic through the city of Cleveland can be taken as an illustration. State Route 13, bypassing to the west of Akron, is now being improved. State Route 91, to the east of Cleveland, will be completed next year. State Route 46, east of Warren and west of Youngstown and State Route 81 south of Cleveland will also soon be open to traffic. State Route 17, south of Youngstown and leading west from Akron, should be completed as soon as funds will permit, as it will give an outlet to these cities that will avoid centers of congestion and relieve traffic on State Route 2, the Cleveland-Buffalo road, which now carries the densest traffic of any route in the state. Examples could be cited in the vicinity of Toledo, Cincinnati and other cities.

The Department of Highways and Public Works of Ohio and the Bureau of Public Roads are now co-operating in a comprehensive transportation survey of Ohio, similar to the one just completed in Pennsylvania. It is contemplated that the data to be obtained will be very valuable to assist in the proper establishment of additional bypass routes on the state system.

Strength of Concrete Bridge Rail and Pressure of Crowd

Springfield Balustrade Fails Under Pressure of 91 Lb. per Foot — Men Able to Push With Force of 168 Lb. per Foot

FOLLOWING a slight accident on the Hampden County Memorial Bridge over the Connecticut River at Springfield, Mass., on Sept. 9, when a skidding taxicab rolled over the curb onto the sidewalk and knocked out part of the concrete balustrade, an investigation of the strength of the balustrade was made for the city by a board of engineers appointed by the mayor. This board was composed of J. E. Greiner, of Baltimore, Samuel M. Green, of Springfield, and Shortridge Hardesty, of New York. The board has reported that it tested the railing and found that it could be overturned by a pressure of 91 lb. per lineal foot applied horizontally at handrail level, while tests of the pressure exerted against a similar railing by a crowd of men showed a maximum force of 168 lb. per lineal foot. Accordingly, the board recommended that the railing be strengthened by additional anchorage, and that the present granite curb separating the sidewalk from the roadway, which is only 5 in. high, be replaced by a reinforced-concrete curb 12 in. high.

Tests of the overturning strength of the railing were made on a railing length of 50 ft., by means of nine levers, each consisting of an inclined wooden plank butted against the foot of the railing and a horizontal tierod extending from the outer end of this plank to the top of the railing, which is engaged by means of a hook. These levers, 11 ft. long horizontally from the foot of the railing, carried weight boxes at their ends, into which sand could be poured as loading. The railing height from the toe of the plank to the tierod was 3 ft. 5½ in., so that a multiplication of slightly over 3 was obtained. The levers were arranged on the bridge side of the railing, to avoid throwing the railing into the river when it overturned, but on account of the symmetry of the railing and its anchorage the results are given as applying in either direction.

Under the weight of the levers and loading boxes alone, which produced a pull of 73 lb. per running foot on the rail, the top of the balustrade deflected ¼ to ⅜ in.,

and the joints between the spindles and the bottom rail opened appreciably. A half pail of sand was then poured in each box, and 2 to 5 min. thereafter a section of the balustrade fell (see view, Fig. 1 herewith), followed within half an hour by failure of the rest of the test section without the addition of further load. The horizontal force exerted by the levers at this time was 91 lb. per lineal foot of railing. The resistance of the balustrade due to its weight alone was computed as being equivalent to 24 lb. horizontal pull per foot. The mortar joints and the anchorage at the railing by 5-in. steel dowels provided the remainder of the resistance.

Tests were then made to determine the pressure that might be exerted by crowds of people pressing against the balustrade. A 10-ft. length of rail was built up, and loading levers similar to those used in the previous tests were placed in such a position as to hold it against the pressure of a crowd of men. A line of seven men pushing moderately against the rail exerted a pressure of 50 lb. per running foot, and when pushing hard a pressure of 81 lb.; 14 men in two lines exerted 81 lb. when pushing easily, 95 lb. when pushing moderately, and 110 lb. when pushing fairly hard; 15 men exerted pressures of 124 and 139 lb.; 20 men in three lines, pushing hard, exerted a pressure of 168 lb. per running foot.

The board concludes from this test that 14 men in a double line on this 10 ft. could have pushed over any section of the balustrade of the bridge. It expressed the opinion that a force of this amount might very easily result from a crowd of people on the sidewalk attempting to look into the river below, or in case of accident or panic, and therefore finds that the railing is

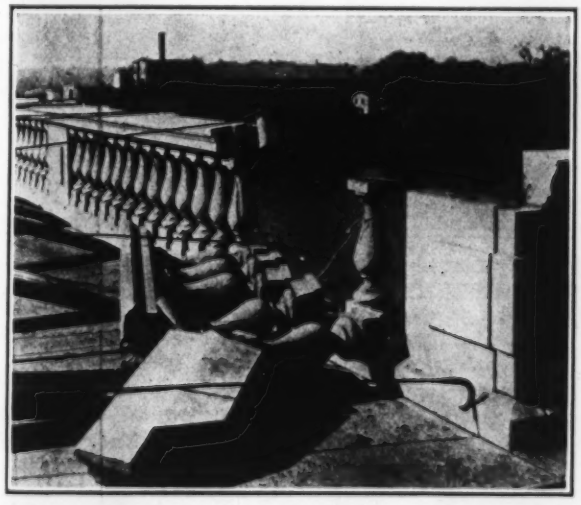


FIG. 1—FAILURE OF PART OF TEST SECTION
This section failed a few minutes after load was placed in the weight boxes. The rest of the test section failed later without additional loading.

inadequate to withstand the pressure which an excited crowd might exert against it.

As the best means of strengthening the railing, the board recommends replacing the two balustrades adjacent to each intermediate joint with a solid rectangular precast stone post 8½ in. thick by 20 in. long, anchoring each such post as well as the existing rectangular posts by ¾-in. anchors (Fig. 2). The balustrade thus anchored would have a horizontal resistance of about 360 lb. per running foot, making it about four times as strong as the existing railing.

Adequate railing strength to resist the impact of automobiles can not be obtained by this method, the board stated. It recommends that automobiles should be prevented from leaving the roadway by a curb of sufficient height. The present curb is only 5 to 6 in. high, and in case of snow or ice on the street or roadway, its effective height will be less. Two cases of

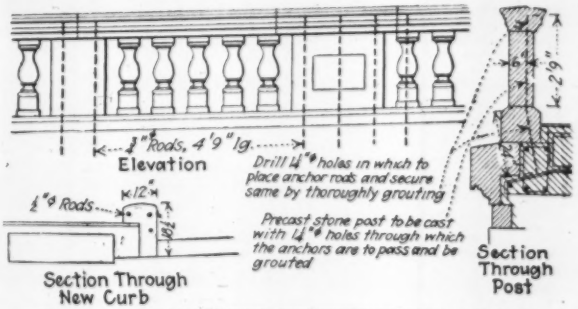

Elevation
Drill 4" holes in which to place anchor rods and secure same by thoroughly grouting
Precast stone post to be cast with 4" holes through which the anchors are to pass and be grouted
Section Through New Curb
Section Through Post

FIG. 2—RECOMMENDED STRENGTHENING OF RAIL AND HIGH CURB

automobiles striking the railing are cited as illustrating the inadequacy of this curb. The board therefore recommends that the present curb be replaced by a curb of reinforced concrete 12 in. high and 12 in. wide (Fig. 2).

The cost of the changes recommended is $12,000 for the railing reinforcement and $6,000 for the higher curb.

The bridge is a monumental reinforced-concrete bridge 1,500 ft. long, completed in 1922, and cost about $6,600,000. It was designed by Fay, Spofford & Thorndike, consulting engineers, of Boston, and was built by the H. P. Converse Co.

Tests of Thermal Expansion of Stone

The determination of the thermal expansion of stone —the change in dimensions with change in temperature—has received very little attention in this country. Furthermore, an examination of the available data on the subject will reveal the fact that the few determinations which have been made are usually based on a very limited number of observations and on coefficients obtained by measuring the length of specimens at normal temperature. The assumption has been made that the material expands at a uniform rate at all intermediate temperatures. Determinations at the Bureau of Standards, in which frequent length measurements were made on limestone and marble specimens as the temperature was raised, indicate that these assumptions are far from correct. For small increases in temperature above the normal the expansion is very small, but the rate increases rapidly as the temperature rises. At 100 deg. C. the average expansion of marble is about the same as that of steel, but at 200 deg. C. the rate is approximately doubled, while for temperatures a few degrees above the normal the expansion is only a fractional part of that of steel. These peculiarities are of particular interest where stone is used in connection with other materials in building construction. Marble also shows the peculiarity of expanding on heating but when cooled to the original temperature it does not shrink to its original dimensions, but retains a part of the expansion as a permanent growth. Specimens have been measured under low temperatures and found to expand when cooled below the normal, which is also contrary to the usual conception.

One of a Series of Articles on the Details of Design and Layout of Different Types of Industrial Buildings

Extension to Textile Mill at Tallassee, Ala.

Column Spacing, Size and Height of Building All Determined by Manufacturing Processes and Machinery Layout—Tarred Sand Between Wood Floor and Concrete Slab

IN THE DESIGN of an extension to the textile mill of the Mount Vernon-Woodberry Mills, Inc., at Tallassee, Ala., a four-story structure was adopted as giving an ideal layout of the machinery for manufacturing light ducks and drills. If the building had been three or five stories high the processes and departments would have been split up in an unsatisfactory manner. The unusually large column spacing, 28x28 ft., was also determined by the layout of machinery and the necessary alley-ways. In the same way, the length and width of the building were determined by the processes, machinery arrangement and general routing of the material in course of production. The construction work is shown in Fig. 1 and the typical design of the building in Fig. 2.

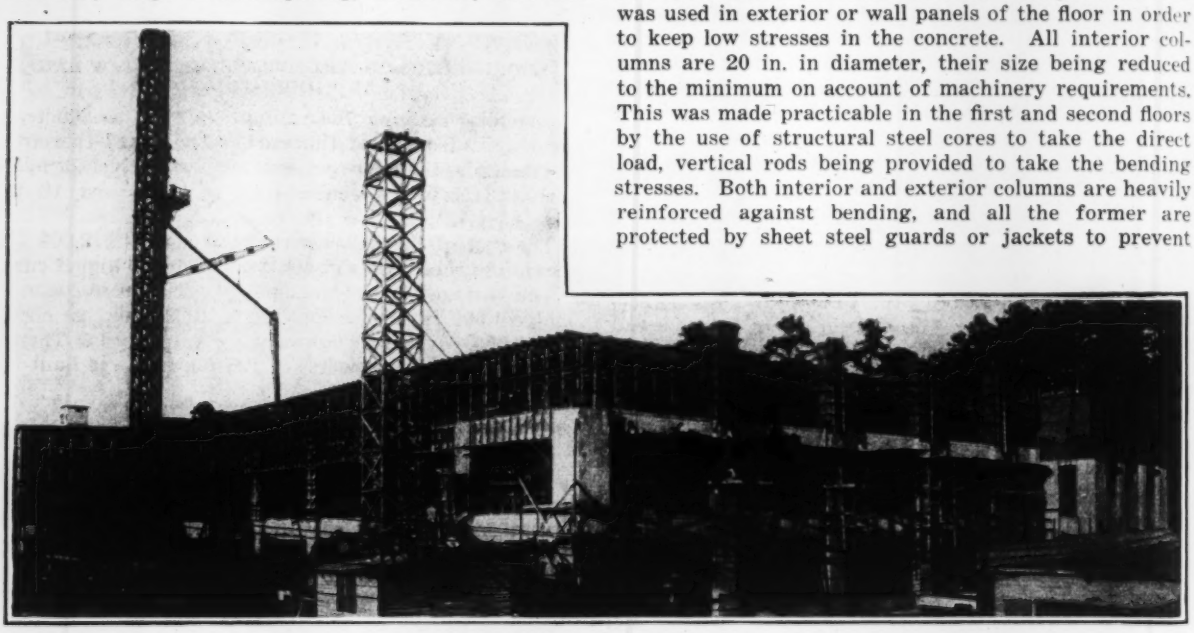


FIG. 1—BUILDING CONCRETE COTTON MILL AT TALLASSEE, ALA.
The old mill building is seen at the left. It also is four stories high.

This mill will contain approximately 30,000 spinning spindles and the necessary preparatory machinery and looms. The machinery layouts in the order of processes are: Carding, drawing and roving on the third floor; spinning, spooling and warping on the fourth floor; and weaving on the first and second floors. Space is also provided on the first floor for the cloth room, where inspecting and packing are done before the goods are shipped. The initial process in picking, which in cotton mills is usually performed on the same floor with the carding, is here done in a separate building which now supplies the picker laps to two existing mills.

The new building, 367x144 ft., is of reinforced-concrete construction of the flat-slab type and so designed as to avoid the use of expensive formwork. Drop panels were omitted and both wall and interior columns are the same size in the four stories. Stairways and elevators are enclosed in two towers which also house the toilet rooms. The floor slab, for 100-lb. live-load, is 11 in. thick, designed according to the recommendations of the American Concrete Institute. Compression steel was used in exterior or wall panels of the floor in order to keep low stresses in the concrete. All interior columns are 20 in. in diameter, their size being reduced to the minimum on account of machinery requirements. This was made practicable in the first and second floors by the use of structural steel cores to take the direct load, vertical rods being provided to take the bending stresses. Both interior and exterior columns are heavily reinforced against bending, and all the former are protected by sheet steel guards or jackets to prevent damage by trucking. Over the basement, a beam and slab construction with 7½-in. slab is used.

For the roof, there is a 9½-in. flat slab having a slope of ¼-in. per foot and covered with five-ply tar and gravel roofing. Insulation under this roofing eliminates ceiling condensation in the top floor. Over the central bay is a monitor about 21 ft. wide and 9 ft. high, with roof of hollow-tile and concrete beam construction in order to reduce the dead-load and also to provide insulation against condensation. Some cotton textile processes require considerable humidity, so that special care must be taken to prevent condensation on walls and ceilings. As there are only two spans on each side of the monitor, it is placed with its walls on the inside edges of the column capitals in order to balance the bending moment over these capitals.

It is of interest to note that the exterior of the building will have no brick or other veneer, the structural concrete of pilasters and spandrels being left exposed. All exterior and interior concrete surfaces are to be

rubbed down with concrete brick. A finishing wash of thin cement grout of the consistency of whitewash will be applied to the outside surfaces, while the inside walls will be painted with mill-white and given a printed dado 5 ft. high. Steel sash, with pivoted ventilating panels operated by hand, constitutes about 75 per cent of the wall area, as is the usual modern practice in textile mills. In order to exclude bright sunlight, the windows have ribbed glass, except for clear glass in the two bottom rows of lights. The sides of the monitor consist almost entirely of steel sash hinged at the top and swinging outward, being operated by hand by means of gears and endless chains. A gutter

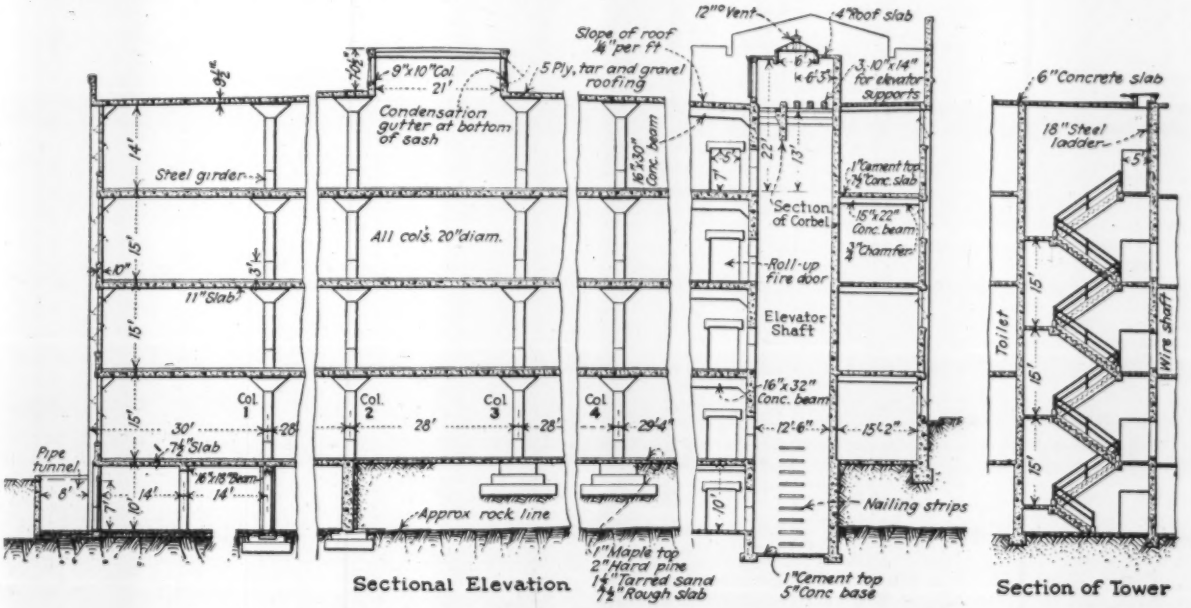


FIG. 2—TYPICAL DESIGN OF REINFORCED-CONCRETE TEXTILE MILL

at the bottom of the sash carries off the condensation noted above. No special provision is made for window cleaning or for condensation on windows.

Floor construction consists of a 1½-in. layer of tarred sand on the concrete slab, covered with 2-in. hard-pine square-edged planks, on which is the wearing floor of 1-in. maple boards. The purpose of the tarred sand is to provide a cushioning effect under the machinery and thus reduce vibration. Maple flooring is used on account of its durability under trucking service. Part of the first floor, on filled ground, has 4½ in. of tar-concrete, covered with 3-in. pine and 1-in. hard maple. Over the basement, the 7½-in. slab has the same flooring as the upper stories.

Part of the foundations are on bedrock near the surface, but elsewhere the columns have spread footings in earth cover above the rock, the allowable loads per square foot being 20,000 and 5,000 lb. respectively. A tunnel for electric wiring extends the full length of the building, and serves a shaft at the tower. Wiring is laid in the sub-flooring to junction boxes from which connections are made to the motors. All wiring is in conduit. A similar but separate tunnel is provided for the steam heat and other piping.

Toilet rooms are arranged in the towers and fitted with flush valves operated by push buttons in the wall. Adjacent to these are the cloak and locker rooms, which have washing sinks. Drinking fountains are located on each floor, in the tower, and are served by a circulating and cooling system, the water being furnished from the present mill supply system. Complete sprinkler equipment on the wet system is provided and is connected to the existing fire protection service of the plant. There are two electric freight elevators 8x10 ft. with load capacities of 4,000 and 2,500 lb. and having semi-automatic counterbalanced doors.

Electric motor drive is used throughout. The spinning frames, spoolers and looms have individual motors mounted on each machine; the roving is done with two- and four-frame motors and the remaining machinery is driven in small groups with a motor on each line of shafting and connected to the line shaft by a silent chain drive. There will be approximately 900 motors, averaging about 2 hp. each. The mill lighting system is by 200-watt bowl enameled lamps and reflectors so spaced as to give a consumption of approximately 1 watt per square foot and an intensity of approximately 6 to 8 ft. candles on the working plane. All electric current is purchased.

In addition to the mill, about 39,000 sq.ft. of additional warehouse space is provided, which includes a new opener room. The warehouses are of standard slow-burning construction, with brick walls and outside connecting platforms of concrete. Their floors are of 3-in. pine, except that on fill they are of concrete with a 1-in. cement wearing surface.

When the building is completed, about 600 employees will be required to operate the mill and 175 tenement houses are provided for the operatives and their families. The village contains modern improvements, such as lighting, water supply, sewerage and paved sidewalks.

This mill extension was designed by J. E. Sirrine & Co., engineers, and was built by Potter & Shackleford, Inc., contractors, both of Greenville, S. C.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Calculating Equal Payments

Sir—The letter of Reeve Conover, p. 844 of your issue of Nov. 20, 1924, deals with a rather important subject as far as rural municipalities are concerned. In my opinion, however, the important subject is not how many payments you will have to make but rather the amount of a given number of equal payments necessary to liquidate the debt. I am enclosing a clipping from the *Monetary Times*, Oct. 15, 1920, giving data on the subject which I had prepared at that time:

With the exception of cases where very long term bonds are issued on securities that have more or less unchangeable value and where it is contemplated that new bonds will be issued to take care of the old ones when they fall due, two general methods of financing are usually followed. First, the individual usually gives a mortgage on some security, under an agreement that he will pay a certain amount of the liability each year with interest at the agreed rate and make final settlement at the end of the term of the mortgage; the second method, followed by municipalities, cities and small corporations, is to sell bonds bearing an agreed rate of interest payable annually, the amount of the bond becoming due at the end of a limited number of years, usually varying between 15 and 30. The municipality, city or corporation prepares itself to meet the obligation by creating a sinking fund, that is, levying an amount of tax or setting aside an amount out of the business as the case may be, which, put out at interest (usually at a rate considerably lower than the rate of interest it is compelled to pay on the bond), so that at the end of the given period the fund thus created will be sufficient to meet the obligation.

The writer believes that a third method—namely, of liquidating the debt by equal annual payments, would in general be more satisfactory and better adapted to rural municipalities and small business concerns, that, in a great many cases, do not have the facilities or the knowledge to handle a sinking fund properly. This latter method would have the advantage that the taxpayer or small business man would not in general be penalized on account of the different rate of interest he would have to pay and what he would receive on a sinking fund, and the writer believes further that such bonds would in general command about as high a price as the bond requiring a single payment at the end of the term of the life of the bond, for the reason that the liability would be constantly decreasing, therefore the security of the bondholder would always be getting safer and it would be only carrying out a principle that is usually insisted on by trust and mortgage companies when making loans to individuals.

In discussing this matter with the officials of a rural municipality, the writer was told by the officials that they would like to issue such debentures, but they did not know how to figure out the amount of the annual payments. This may be the reason why this form of debenture is not more popular. The problem, however, is not a very difficult one, for the reason that the percentage of the debt to be paid each year is equal to the amount of $1 for the given number of years, at the agreed rate of interest compounded, divided by the amount of $1 per year for the given number of years, at the agreed rate of interest compounded; that is, if we let R equal the rate of interest and N the number of annual payments, then P, the percentage of the debt to be paid each year, will equal

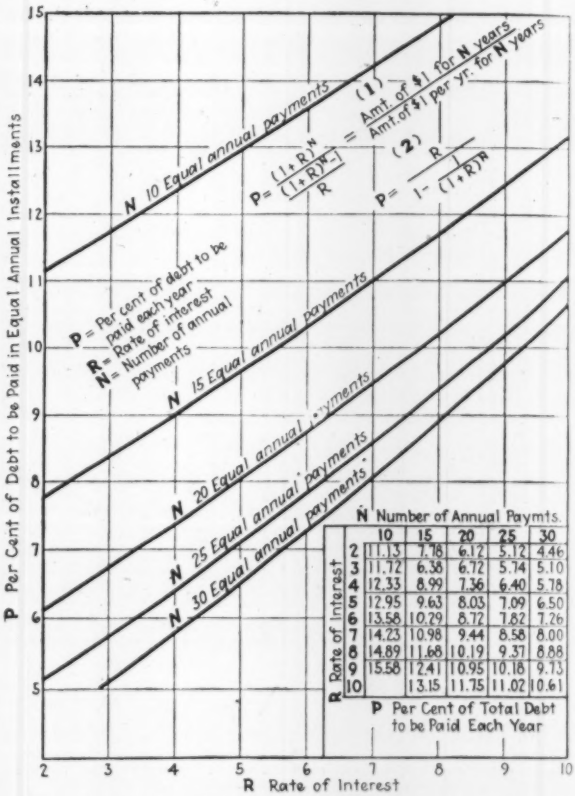
$$P = \frac{(1+R)^N}{\frac{(1+R)^N-1}{R}} \qquad \text{(1)}$$

this can be reduced to

$$P = \frac{R}{1-\frac{1}{(1+R)^N}} \qquad \text{(2)}$$

The terms of the numerator and the denominator of equation (1) can be taken from compound interest tables and, dividing the numerator by the denominator, P can be found to a value extending to the fifth or sixth decimal place. The converse of this problem is not such an easy one. That is, if you had given a number of equal annual payments to liquidate a debt of a given sum, you could find the value of P by dividing an annual payment by the total sum, but, having given P, it is not so easy to find out the value of R, that is, the rate of interest that you are actually paying.

To facilitate and explain this matter in general the writer has prepared a chart, which gives in the table the percentage of the total debt to be paid each year in 10, 15,


P Per Cent of Debt to be Paid in Equal Annual Installments
R Rate of Interest
N 10 Equal annual payments
N 15 Equal annual payments
N 20 Equal annual payments
N 25 Equal annual payments
N 30 Equal annual payments
(1) Amt. of $1 for N years / Amt. of $1 per yr. for N years = P = (1+R)^N / ((1+R)^N − 1) / R
(2) P = R / (1 − 1/(1+R)^N)
P = Per cent of debt to be paid each year
R = Rate of interest
N = Number of annual payments
N Number of Annual Paymts.
R Rate of Interest
P Per Cent of Total Debt to be Paid Each Year

R	N=10	15	20	25	30
2	11.13	7.78	6.12	5.12	4.46
3	11.72	8.38	6.72	5.74	5.10
4	12.33	8.99	7.36	6.40	5.78
5	12.95	9.63	8.03	7.09	6.50
6	13.58	10.29	8.72	7.82	7.26
7	14.23	10.98	9.44	8.58	8.00
8	14.89	11.68	10.19	9.37	8.88
9	15.58	12.41	10.95	10.18	9.73
10		13.15	11.75	11.02	10.61

CHART FOR COMPUTING EQUAL ANNUAL PAYMENTS

20, 25 and 30 annual payments, at rates of interest varying in even percentages from 2 per cent to 10 per cent. By plotting this table as shown in the chart, we have a means of determining R. Having given P, and the number of equal annual payments, it is very easy to determine within a very small fraction, the rate of interest that is being paid.

For instance, if you are paying $1,600 per year to liquidate a debt of $20,000, the percentage paid each year would be 8 per cent of the total debt. If the agreement called for 15 equal annual payments, you would be paying interest, approximately, at the rate of 2.4 per cent. If it was 20 equal annual payments, you would be paying interest at the rate of 4.94 per cent; for 25 equal annual payments, interest would be 6.23 per cent, and for 30, 6.94 per cent.

Take another example. Suppose a municipality sells a 20-year 5 per cent bond at par and arranges to take care of the debt by a sinking fund estimated on a basis of 3 per cent compound interest. For every dollar sold the taxpayer will have to pay each year, for 20 years, 5 cents as interest and 3.72 cents to sinking fund, or a total of 8.72 cents, which is the equivalent of paying about 6 per cent for money, while if the equal payment method was used, only 8.03 cents per dollar would have to be collected. On a basis of the above assumptions, the municipality could afford to sell such bonds at 92.1, a difference that the writer does not believe any bond broker would make in a tender for the two kinds of bond at same rate of interest.

Winnipeg, Man., Canada, Nov. 25, 1924.

J. G. SULLIVAN, Consulting Engineer.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Reclamation to Be Studied By Engineering Council

Inauguration of a comprehensive investigation of the nation's reclamation problems was decided upon by the assembly of the American Engineering Council at Washington, Jan. 16. The investigation was assigned to a committee headed by W. B. Powell, of Buffalo, and including in its membership Prof. H. B. Walker, Manhattan, Kan.; Ira W. McConnell, Washington; R. S. Maddox, Nashville; C. E. Jacoby, Kansas City; W. S. Mitchell, St. Louis; and F. H. Newell, Washington.

Bureau of Reclamation May Study Butte-Beer Creek Project

An investigation of the proposed Butte-Beer Creek project near Chico, Calif., probably will be undertaken by the Bureau of Reclamation, the California Development Association, and the University of California. In this instance there is no question as to the agricultural possibilities of the land. The entire problem is to secure the land, which is in private ownership, at a cost which will be fair and which will give an opportunity for the settler to receive an adequate return from the property. Before any effort, however, is made to ascertain the economic possibilities of the project, assurances will be sought from the land owners as to their willingness to give up their excess holdings at the appraised price. Unless commitments can be obtained from the land owners, which will make it possible to sell the land to settlers at a thoroughly reasonable price, no economic investigation will be initiated.

Am. Soc. C. E. Members Guests at A.W.W.A. Section Luncheon

The New York Section of the American Water Works Association held its January luncheon meeting Jan. 22, between the morning and afternoon sessions of the Sanitary Engineering Division of the American Society of Civil Engineers, and invited those in attendance at these meetings to join in the luncheon and subsequent proceedings. The official records showed 176 at the luncheon. D. W. French, section chairman, expressed the hope that similar joint luncheon meeting might be held in the future, with programs chosen to suit the members of both societies. Before adjournment, resolutions on the death of Secretary-Emeritus John W. Diven were adopted.

Following the luncheon there were addresses by Albert L. Webster, consulting sanitary engineer, and A. E. Hansen, hydraulic and sanitary engineer, both of New York City and both members of the subcommittee on plumbing of the Building Codes Committee appointed by Herbert Hoover, Secretary of Commerce. Mr. Webster summarized those portions of the recently submitted report (obtainable for 35c. from the Superintendent of Documents, Washington, D. C.) of most interest to water-works engineers and superintendents. He prefaced his summary by some unusually interesting remarks on the relationship of plumbing and water-works, with clever references to the water supply of the Equitable Building and the Pennsylvania Hotel, the luncheon meeting being held at the latter. The water consumption at the Pennsylvania Hotel is some 900,000 gal. per day, Mr. Webster stated.

Mr. Hansen, before giving the details of the plumbing report, paid tribute to the committee work done and its chairman, the late Prof. George C. Whipple. Mr. Hansen expressed the desirability of giving more instruction to engineering students in matters of plumbing, remarking that it is difficult for sanitary engineers to find young assistants who are versed in the subject. By way of informal discussion, there was only time to hear from W. W. Brush, deputy chief engineer of the New York Department of Water Supply, who outlined briefly such attempts as are made by the department to regulate water-supply piping and accessories in buildings in New York City. These, the speaker indicated, do not go as far as they might well do, but the New York Water Department is not peculiar in that respect.

Engineering Fifty Years Ago

From *Engineering News*, January, 1875

IN JULY, 1871, a sample of Abbott's concrete pavement was laid on top of the stone paving in Superior St., Cleveland, on the east side of Monumental Park. The concrete, thus far, has not shown the least indication of wear or defect of any kind. The present indications are that the pavement will prove a success, although it has not had sufficient time to give it a thorough and satisfactory test.

Concrete pavements have in a majority of cases proven a total failure in this country. There is evidently a want of knowledge or skill in the construction of this class of pavement, for it is not an uncommon occurrence to see two pieces of paving evidently laid with the same care, and purporting to be precisely of the same material, yet one may prove a success and the other a total failure. It is this uncertainty that prevents its being more generally adopted, for it is superior to all other pavements in point of smoothness and cleanliness, and if it could always be relied upon, it would be more universally adopted.

Am. Soc. C. E. Has Successful Annual Meeting

Hoover Made Honorary Member —Nobel Prize Committee Reports —Sesquicentennial Action

The 77th annual meeting of the American Society of Civil Engineers held in New York City, Jan. 21-23, maintained all the traditional success of this meeting. Wednesday morning was given over to the presentation of the medals noted in last week's issue and the conferring of honorary membership on Herbert Hoover, Secretary of Commerce and member of the society. Mr. Hoover, in a well-phrased acceptance speech, emphasized the pride that the professional man has in recognition by his own profession and acclaimed to engineers the honor he had received from the society as an honor accorded to the engineer who enters public service.

The financial report showed that the society was in good condition, having added some $23,000 to the cash on hand and satisfied all the society's obligations of the past year. The book assets of the society today are $1,350,435, with a surplus of $990,693. Additional student chapters were added at the University of Georgia and the Armour Institute and a local section to the state of Arizona. As noted last week, the Board of Direction has adopted a model registration law and also passed a resolution favoring the encouragement of commercial flying and of the air mail service. The board reaffirmed its expression of the approval of a department of public works, but maintained that that department would be better served if it included all of the engineering services of the government, especially the river and harbor work now under the Corps of Engineers, which is not included in the current bill before Congress.

Noble Committee Reports

The committee on the Alfred Noble Memorial reported that they had in hand only $14,356, and, as there appears to be no hope of raising the intended $100,000, the committee recommended that the money be placed in the custody of the United Engineering Society to hold and reinvest and that the trustee pay one-quarter of the income to each of the four founder societies for a prize on any subject selected for juniors or students not more than 26 years of age. This report was referred to the Board of Direction, which referred it back to the committee with instructions to make further studies, the board evidently being unwilling at this time to admit that it is impossible to get together enough funds to erect some sort of memorial to Mr. Noble.

The board also ordered the president to appoint a committee to consider the

subject of contract bonds and withdrew from the proposed inter-society promotion of a sesquicentennial engineering congress in Philadelphia which was to be held in 1926.

Wednesday afternoon was given over to the reports of the committees of the society as noted on p. 196 of this issue. Thursday was devoted to five divisional meetings. The technical discussions on highways, city planning, power, and sanitary are reported elsewhere in this issue; a new section on structural was formed. A comparatively small audience was attracted by the papers and discussions at the division meetings, the maximum at any one being about 150.

The entertainment features comprised a smoker on Thursday night, at which a skit purporting to be a meeting of the Amalgamated Association of Whatnot Engineers was put on by the New York Section. It was a take-off on the numerous adjectival engineers, which have been featured in the "Random Lines" column of *Engineering News-Record*. On Friday an excursion to West Point and Bear Mountain was attended by some 375 members and guests. The program included an inspection of West Point under the guidance of army officers, a view of the new Bear Mountain suspension bridge, and a luncheon at Bear Mountain Inn. On Friday night there were the usual number of college alumni dinners. The Sanitary Section also had a joint meeting with the American Water Works Association.

The following officers were elected for the ensuing year: President for one year Robert Ridgway, New York; vice-presidents for two years, Milo S. Ketchum, University of Illinois, Richard L. Humphrey, Philadelphia; directors for three years, Willard Chevalier, New York, Charles Gilman, New York, Paul Norcross, Atlanta, Albert R. Raymer, Pittsburgh, C. M. Spofford, Boston, and H. P. Dewell, San Francisco.

New Orleans City Engineer Put Up for City Commissionership

Two of the three "factions" of the democratic party in New Orleans are putting forward John Klorer, city engineer, as a candidate for the membership on the city commission or council at the election late in the current month. At latest reports it seemed likely that the third faction would also endorse Mr. Klorer and that his election was assured, in which event it is expected that his four fellow commissioners will make him head of the city department that has charge of public works.

Mr. Klorer was appointed city engineer of New Orleans in 1921. He was then principal assistant engineer of the state board of engineers. Before that he was a civil engineer in the U. S. Engineers Office at New Orleans. He has been one of the backers of the project for a spillway system on the Mississippi as a means of flood control and read a paper on the subject before the New Orleans meeting of the American Society of Civil Engineers in 1923.

Contract Let for 280,000-Hp. Hydro Plant

Contracts for the construction of the hydro-electric power plant on the Susquehanna River near Conowingo, Md., have been let to Stone & Webster, Inc. The plant is being built for the Susquehanna Power Co., a subsidiary of the Philadelphia Electric Co. The estimated cost of the work is about $52,000,000. The initial installation is to be 280,000 hp. with provision for a total installation of 460,000 hp. Details of the project were given in *Engineering News-Record*, Jan. 8, 1924, p. 90.

Standards Committee At Work On Bridge Specifications

Strong difference of opinion as to the possibility of working out national standard bridge specifications developed on Jan. 7 at a meeting of a special committee, under the chairmanship of C. R. Harte, appointed by the American Engineering Standards Committee to report on four specifications for steel bridge design and construction submitted to the committee within the past year. These are: The general specifications for steel railway bridges and the specifications for movable railway bridges, of the American Railway Engineering Association; and the specifications for design and construction of steel railway bridge superstructure and the specifications for design and construction of steel highway bridge superstructure, of the American Society of Civil Engineers. The special committee to which they were referred for recommendation contains representatives of the various organizations interested in railway and highway bridge work.

Following considerable discussion and correspondence, the Special Committee at its meeting on January 7, voted to make the following recommendations: (1) That work on highway bridges should be allowed to develop further before attempting national standardization through a sectional committee; (2) that the unification of railway bridge specifications should be undertaken under a thoroughly representative sectional committee, and that the American Railway Engineering Association and the American Society of Civil Engineers should be invited by the A.E.S.C. to act as joint sponsors for the sectional committee. The latter recommendation did not receive the endorsement of the A.R.E.A. representatives on the special committee, however, on the claim that the A.R.E.A. could not share sponsorship for railway bridge specifications with any other organization. At the meeting of the A.E.S.C. executive committee on Jan. 8, the first recommendation was approved, but, upon the recommendation of the A.R.E.A. representative, action on the second recommendation was deferred pending a further discussion of the subject at the forthcoming meeting of the A.R.E.A.

Hering Memorial Medal Assured

Progress on the proposed Rudolph Hering memorial medal was reported to the Sanitary Division of the American Society of Civil Engineers on Jan. 22 by Samuel A. Greeley, in behalf of the committee in charge. A fund of about $1,600 has been collected, which is thought to be sufficient to pay for a design and a die and leave an investment fund sufficient to strike a medal each year. The executive committee of the division was empowered to carry through the project.

Dam Dynamiting Charge Made

A man said to have sought employment unsuccessfully of the Mathieson Alkali Works is held without bail in the county jail at Marion, Va., on a charge of having dynamited the dam at Saltville causing the death of 19 persons and heavy property damages. Authorities say they have evidence as to his guilt though the man declares he can establish an alibi. The details concerning the dam failure were contained in *Engineering News-Record*, Jan. 8, p. 91.

Plan Outlined for Financing $100,000,000 St. Louis Subway

C. E. Smith, consulting engineer for St. Louis, Mo., submitted on Jan. 16 to a special aldermanic committee on rapid transit a progress report on a plan for financing the proposed $100,000,000 subway and rapid-transit system for the city and its environs. Mr. Smith recommended that special assessment against the benefited property be levied to finance the subway in whole or in part. City Counselor Senti is studying the statutes to ascertain whether the city has the power to levy such assessments and what additional legislation is needed for it to do so.

Mr. Smith favored the special assessment plan of financing first on the grounds that equity and good business policy favor those benefiting through a public improvement paying the cost of such improvement, and second, because the cost of a comprehensive subway system sufficient to care for the city's needs would be too great for the patrons of such a system alone to meet.

In October, 1924 a special aldermanic committee, following a tour of Eastern cities, recommended that the city of St. Louis vote $100,000,000 in bonds for a transit system. An appropriation of $25,000 was voted to pay the cost of preliminary work.

A rapid-transit council of citizens is working up public sentiment for the subway system and engineers and traffic experts under the direction of Mr. Smith are studying car and vehicular traffic, car schedules and seating capacities, points where traffic slows up, etc., to decide in what sections rapid transit is needed. Data on car traffic are being obtained, profiles of street grades are being made, and subsoil and other investigations are being carried on to determine the most likely points for both subways and elevated.

It is probable that at least a year will elapse before the electorate passes on the plan.

Causeway Over Lake Pontchartrain Proposed

A causeway 23.3 miles long to cost in the neighborhood of $12,000,000 is proposed to span Lake Pontchartrain, near New Orleans. The Pontchartrain Causeway Association, Inc., has been formed with William Pfaff, president of the association of commerce in New Orleans, president, and with Charles E. Fowler, consulting engineer, Detroit and New York City, as chief engineer to the association.

The causeway will contain in its length of 23.3 miles two bascule bridges and not less than 6 miles of concrete trestle. There will be about 18 miles of fill. According to Mr. Fowler, the financing is being arranged and plans are being prepared.

When completed, the causeway will open up from 1,000,000 to 2,000,000 acres of orange and strawberry land and suburban residence districts for New Orleans.

Rensselaer to Hold Reunion

The annual mid-winter reunion of Rensselaer Polytechnic Institute will be held at Buffalo, N. Y., Feb. 7. An inspection trip to the Niagara Falls Power Co. has been planned and luncheon will be served at the Lewiston Country Club. On returning to Buffalo, the business meeting will convene at the Hotel Statler. The banquet is at 7 p.m. Director Rickets, of the Institute, Samuel Botsford, of Buffalo, and Charles Robinson, of the Cleveland *Plain Dealer*, are to be the speakers.

Construction Men Confer on National Defense

At Washington on Jan. 16 representatives of the construction industry conferred with the Secretary of War and officers of the Army in regard to the plans of the War Department for national defense, in so far as those plans are concerned with construction. The initiation of this meeting came from the Secretary of War, in pursuance of a policy which he has inaugurated of calling in various industries to discuss the features of the War Department's plans which are interesting to them and on which they have expert information. Last fall he appointed a committee of 41 from various fields in the construction industry to discuss the matter with him in a preliminary fashion. This committee advised the Secretary to have another meeting at which representatives of various technical associations would be present. This meeting is the one which was held on Jan. 16.

There were in attendance well over 100 men. The Secretary of War outlined the policy which he has been enforcing. The Quartermaster General of the Army, Major-General Hart, welcomed the body and emphasized the need the army had for civilian assistance in this detail planning, and Lt.-Col. W. J. Johnson, of the General Staff, gave an outline of the general mobilization plan required of the War Department under the National Defense Act. Francis Blossom, consulting engineer of New York, read an address entitled "Wartime Service of Construction," which emphasized the effective final development of the construction service in the late war, at the same time pointing out the difficulties of organization which should be overcome in case of another war if experience of the late war is considered.

At the end of the day a resolution committee which had been appointed submitted the resolutions which were adopted. The main feature of these resolutions is embodied in the final resolution as follows:

"*Resolved*, that we, as the representatives of national organizations interested in construction hereby agree to recommend to our respective organizations that they co-operate with the Secretary of War's civilian conference committee on War Department construction and that each organization designate a representative to meet upon request with such conference committee to the end that the experience of the construction industry in this country gained in the late war may be made available to the War Department and that the construction industry may be mobilized to aid the War Department in the event of another major emergency."

A.R.E.A. Nominates Officers

The official list of nominations of officers of the American Railway Engineering Association for 1925 includes the following: President, J. M. R. Fairbairn, chief engineer, Canadian Pacific Ry.; vice-president, D. J. Brumley, chief engineer of Chicago terminal improvements, Illinois Central R.R.; treasurer, Geo. H. Bremner, engineering department, Chicago, Burlington & Quincy R.R.; secretary, E. H. Fritch, Chicago. In addition there are nine nominations from which to select three directors, and ten nominations from which to select five members of the nominating committee. The annual meeting of the association will be held at Chicago on March 10 to 12.

American Falls Dam Contract Goes To Utah Construction Co.

Washington Correspondence

The contract for the construction of the American Falls dam was awarded by the Secretary of the Interior to the Utah Construction Co. on Jan. 24. This company's bid of $1,281,000 was lowest. Other bids were: James O. Heyworth, $1,380,000; Strange-McGuire, $1,354,000; Atkinson & Atkinson, $1,319,000.

Bids received under the earlier call, on Oct. 20, were $1,500,000 and $1,560,000 for the low dam (only two contractors bid), and $400,000 more for the high dam (low dam and high dam are for storage capacities of 1,040,000 and 1,740,000 acre-ft., respectively).

The present bids are for the low dam on a base wide enough for the high dam, but will apply also to construction of the high dam (on the same unit prices but with a deduction for decrease in plant charge) if this is ordered before work has extended above the base.

New Indiana Section of A.W.W.A. Meets

Successor to Indiana Sanitary and Water Supply Association Has Convention

The water-works men of Indiana met for the first time as a section of the American Water Works Association on Jan. 22-23, at Indianapolis, this section succeeding the former Indiana Sanitary & Water Supply Association. Teamwork between fire departments and water companies was advocated by J. J. O'Brien, city fire chief, and the value of courtesy on the part of employees of public utility concerns was stressed by Dow R. Gwin, Terre Haute. In a round-table discussion on handling the accounts of slow paying consumers, E. M. Sherborne, of Knightstown, reported that he used no collectors and lost in 1923 only 75c.; in 1924 he lost $2.35, but expects to obtain at least part of it eventually. W. F. Peter, Seymour, lost one month's bill from a man who left town overnight.

Relative installation and operating costs of steam and electric pumps were discussed by F. S. McClintock, chief engineer of the Dravo-Doyle Co., Pittsburgh, Pa. The discussion brought out instances of economy due to a change from steam to electric power. That Indiana streams can furnish 180,000 hp. without storage was stated by Richard Lieber, director of the State Department of Conservation, as based upon stream - flow measurements; about twenty gaging stations have been established. As to where the pumped water goes between midnight and 6 a.m., E. J. Jenkins, of East Chicago, accounted for this as going to industries. At Jeffersonville, J. O. Endris finds much is unaccounted for, but as the town is largely unmetered a considerable quantity goes down the sewer as consumers allow it to run to prevent frozen pipes. Measurement of pipe flow by the coordinate method, where weirs are not available, was presented by Prof. F. W. Greve, Purdue University. J. W. Moore, Indianapolis, detailed basic conditions governing the placing, conditioning and equipment of wells.

An address by F. C. Jordan, president of the American Water Works Association, outlined the aims of the association and referred to the opportunity for the new Indiana section to get in contact with the parent body at the Louisville meeting next Spring. The attendance at the meeting was about 175. Officers were elected as follows: President, J. O. Endris, New Albany; vice-president, Wm. Luscombe, Gary; secretary and treasurer, C. K. Calvert, Indianapolis.

More Chicago Track Elevation

The Chicago & Western Indiana R.R. intends to elevate its tracks from 94th St. south to the city limits during 1925-1927 at a cost of nearly $8,000,000. The extension of the work north to the Dearborn terminal station is planned, but must wait the completion of plans for new passenger terminals. For the entire project the estimate is about $27,000,000.

Congress Changing Attitude Toward Reclamation

Western Congressmen Realize Projects Must Have Economic, Not Political Stability

Washington Correspondence

Western senators and representatives are realizing as never before that reclamation must be put on an economic rather than a political foundation. They have had unmistakable evidence recently that Congress is sensing the adverse public opinion being built up by the very evident intent on certain projects to wring just as many concessions from the federal government as possible. Many of the water users apparently have quit paying and are relying on political pressure to extricate themselves from their obligations to the federal government which they are not meeting. Despite the fact that 1924 has been a fairly favorable year on the projects, there is a veritable mania for writing off. This has given further color to the belief in some quarters that reclamation is a failure and that the federal government should withdraw as quickly as possible from these ventures.

As a result, Western senators and representatives are not as ready as they once were to urge extensions of obligations. They are very active in their efforts to increase the ability of the water user to pay his obligation, but there is little support for further relief measures. There is general opposition to blanket release.

Credit Aspects

It is being pointed out that the Bureau of Reclamation is not a credit agency. Water users who require funds for meeting private obligations have access to the War Finance Corporation and to the federal land banks. It is believed that any attempt to have the Reclamation Bureau function as a credit agency and to sanction the postponement of payments for its services in order that the principal and interest of other debts may be paid will demoralize its finances hopelessly and so discredit it as to endanger the whole reclamation structure.

There is no authority under the relief act of May 9, 1924 to grant extension of operation and maintenance charges for 1924. The moratorium of three years authorized by Section F of the fact-finder's law is contingent upon operation and maintenance of construction work being taken over by the water users. There can be no general moratorium under the present law until appropriate contracts are executed. These contracts cannot be made intelligently, it is believed, until after comprehensive surveys have been completed and the essential data studied by the Boards which will visit the projects.

Apparently the point has been reached where the Bureau of Reclamation must insist that contracts be kept and all obligations of water users met. The adjustment committees will recommend to Congress the specific relief that may seem necessary, but that relief cannot include the payment of operation and maintenance expenses.

Roger M. Freeman Dies

Roger M. Freeman, New York City, consulting and construction engineer of great ability and promise, died Jan. 22 of heart failure following an attack of appendicitis; he was in his 33rd year.

The consulting practice in which Mr. Freeman had been engaged in since 1921 was in the design and construction of industrial buildings, steel plants and power plants. One of the recent projects was in connection with a hydro-electric development on the Tippecanoe River, in Indiana.

Mr. Freeman was born in Winchester, Mass., in 1892. When he was three years old the family moved to Providence, R. I., where his early education was obtained. Later he entered Massachusetts Institute of Technology, graduating therefrom in 1913 in electrical engineering. For two years he served as assistant engineer with his father, John R. Freeman, well-known consulting engineer of Providence, on the design of large hydro-electric developments in this country and Canada. He then joined the staff of the Turner Construction Co. and was located at Thomaston, Conn., but later left that company to become associated with the Chase Co., Inc., to build up an organization and to direct the design and construction of industrial buildings, mostly reinforced-concrete factories. In service during the War as a government engineer connected with the Navy Department he built the extensive armor-plate plant at Charleston, W. Va. Later, as supervising engineer, U. S. Navy, Bureau of Yards and Docks, he was in charge of construction of the Erie Forge & Steel Co. at Erie, Pa., a forging plant for the Pollak Steel Co., at Cincinnati, a heat treatment plant for the Allis-Chalmers Co. at Milwaukee, Wis., and other large plants.

Canadians Confer on Railway Into Peace River Country

An important conference of railway and government officials was held at Ottawa on Jan. 9 to consider the construction of a new railway into the Peace River country in Alberta to open up an area of about 20,000,000 acres of arable land. Among those present were the presidents of the Canadian Pacific Ry. and the Canadian National Ry., E. W. Beatty and Sir Henry Thornton, the Minister of Railways, the Minister of the Interior, and the premiers of Alberta and British Columbia. The conference was united in the opinion that duplicate routes should be avoided and the Minister of Railways stated that only one line would be approved by the government.

It was decided to leave the matter in the hands of the executives of the two railway systems to conduct a joint investigation, and, if possible, to agree upon a line in the construction and operation of which both roads would co-operate. Another conference will be held in the near future at which time the report of this investigation will be presented so as to have the matter ready for the necessary legislation during the coming session of Parliament.

Random Lines

A Pen Sketch

By ELLDEE

We have an old ball-headed pen that we have used time and again for plus or minus ten long years, for lettering and shading weirs, and hatching sections of cross-ties and making blots and spearing flies; and still it's more efficient far than most new model scratchers are. We would not part with that old pen for any sum of jingling yen! The Higgins ink that's passed its nibs in all these years by little dribs, if canned and sealed like sauer kraut and then by proper flume let out, would furnish power to operate the jaws of every chewing skate from Timbuctoo to Baltimore who 'sighted' at the cuspidor, but missed and 'tied in' with the floor! The hieroglyphics, Reinhart style, (it is to anything but smile) we've made with that historic quill, if snared and made into a pill and rolled on him—dingbust his hide—who opens up the windows wide and lets the cold draft on us zoom and chills the whole danged drafting room—would make a pancake of his frame—forever end his misfit game!

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He who was once derided as a walking dictionary is now consulting engineer to the cross-word puzzlers.—Philadelphia *Public Ledger.*

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Who Said There Was Never Any Money in a Road-Building Contract?

When the Westchester County (N. Y.) Park Commission the other day opened bids for the removal of Money Hill, on the Hudson River at Croton, it announced that a clause would be inserted in the contract stipulating that if any of Captain Kidd's buried treasure was unearthed from the hill it was to be turned over to the commission.

Money Hill was so named owing to a legend that somewhere within it reposed part of the pirate's gold. Residents thereabouts frequently have reported finding Spanish pieces-of-eight and other coins of ancient mintage, but no effort ever had been made to penetrate Money Hill.

There are about 55,000 cu.yd. of the hill. It will be removed in the process of widening and raising the grade of the Albany Post Road near Croton Point.—*The World,* New York.

* * *

Burn Up the Sewage

Chicago is wasting its time worrying about how much lake water it needs to carry its sewage away. Burn it up, and save the water, that's the way to take care of it. At least the editor of the Davenport (Ia.) *Daily Times* has information to that effect or he would not have written the following paragraph:

> If the 4,000 ft. per sec. flow is not adequate to the sanitary demands of Chicago, that city will be called upon to make a great investment in incinerators and other methods of disposal.

Engineering Societies

Calendar

Annual Meetings

AMERICAN WOOD PRESERVERS ASSOCIATION, Chicago, Ill.; Annual Meeting, Chicago, Ill., Feb. 3-5, 1925.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 24-27, 1925.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, Ill., March 10-12, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Cincinnati, April 22-24, 1925.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Louisville, Ky., April 27 to May 2, 1925.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 22-26, 1925.

The Illinois Section of the American Society of Civil Engineers, Dec. 18, elected the following officers for 1925: President, Charles B. Ball, new vice-president, D. J. Brumley. Holdover officials are T. L. D. Hadwen, vice-president, and W. D. Gerber, secretary-treasurer. The election followed a dinner given in co-operation with the Western Society of Engineers, in honor of the Engineering Board of Review of the Sanitary District.

Kansas Engineering Society held its annual meeting at the University of Kansas, Lawrence, Kan., Dec. 10 to 12, and elected officers as follows: President, L. E. Conrad, professor of civil engineering, Kansas State Agricultural College, Manhattan, Kan.; vice-president, W. E. Baldry, city engineer, Topeka, Kan.; secretary, Earnest Boyce, engineer of State Board of Health, Lawrence, Kan.

The Montreal Branch of the Engineering Institute of Canada at its Jan. 8 meeting had a talk by O. O. Lefebvre on the Kenogami dam, and on Jan. 15 a talk by R. A. C. Henry on some of the economic phases entering into adjustment of motor vehicles to railway requirements.

The London (Can.) District Branch of the Engineering Institute of Canada at its annual meeting elected as president, W. C. Miller, city engineer of Thomas; as vice-president, Charles Talbot, London; as secretary-treasurer, E. A. Gray, London. At the annual dinner, George Hogarth, chief engineer of the Department of Provincial Highways, gave a detailed account of the work being done by the department.

The Kansas-Missouri Contractors' Association at its second annual meeting held in Kansas City, Mo., Jan. 16-17 elected the following officers: President, W. G. Dickie, of Kansas Paving Co., Topeka, Kan.; vice-president, A. L. Cook, Ottawa, Kan.; treasurer, E. W. Geiger, of Geiger-Rutherford Construction Co., Leavenworth, Kan. Clark Mandigo was re-elected secretary-engineer. The offices of the association are at 616 Dwight Building, Kansas City, Mo. The membership comprises 53 general contractors doing public works construction exclusive of buildings.

The Phoenix (Ariz.) Chapter of the American Association of Engineers has elected officers as follows: Henry Rieger, city engineer of Phoenix, Ariz.; B. A. McNelly and J. B. Girand, first and second vice-president, respectively; Ralph Hoffman, secretary.

The Northwest Branch of the Associated General Contractors of America will hold its annual meeting Feb. 3-5 at the St. Paul Hotel, St. Paul, Minn. George Walbridge, general manager of the Walbridge-Aldinger Co., Detroit, Mich., and the new president of the Associated General Contractors of America, will give an address.

Personal Notes

FREDERIC L. WAUKLYN, general executive assistant of the Canadian Pacific Ry., has resigned from that position which he held for twelve years. Mr. Wauklyn formerly held important engineering positions in Italy, and was for a time manager and chief engineer of the Montreal Street Ry. He is succeeded as genereal executive assistant by W. B. Howard.

JAMES B. FRENCH, consulting engineer, 50 Church St., New York, announces his association with RALPH W. NICKERSON, consulting engineer, for the general practice of structural engineering. Mr. French will continue his practice in the design and construction of bridges and the heavier types of structures in masonry, steel and timber. Mr. Nickerson, who has had twenty-one years experience with the American Bridge Co., will specialize in structural design of buildings including foundations and superintendence of construction.

V. AVERY THOMPSON, city manager of Phoenix, Ariz., for the past year, has resigned effective Feb. 1 to join the contracting firm of Claude Fisher, Los Angeles. Mr. Thompson was superintendent of the Phoenix Water-Works before he became city manager, having been connected with the plant under private and public ownership for 21 years.

J. W. FOX, formerly locating engineer for the Appalachian & Western North Carolina R.R. at Greensboro, N. C., is now right-of-way engineer for the Florida East Coast Ry. at St. Augustine, Fla. From 1911 to 1920 Mr. Fox was in the engineering department of the Central of Georgia Ry. as valuation engineer, and chief engineer for the corporation during federal control.

E. N. TODD has been appointed state highway engineer of Kentucky succeeding Joe S. Boggs, resigned. Mr. Todd has been with the Kentucky Highway Department since July 1, 1924, as engineer of construction. Prior to that date he was with the Oklahoma State Highway Department. From 1906 to 1920 he was in the federal civil service with the construction division of the army, seven and one-half years of this time rated civil engineer and superintendent of construction. Mr. Todd has had highway experience in six states, the District of Columbia and the Philippine Islands.

W. A. MCLEAN, former deputy minister of highways of Ontario, who organized the highway system of the province, has joined the firm of R. O. Wynne-Roberts & Son, Toronto, civil and consulting engineers. The firm will be known as Wynne-Roberts, Son & McLean.

WEBSTER L. BENHAM, of the Benham Engineering Co., consulting engineers, Kansas City, Mo., announces affiliation of his company with Dr. J. A. L. WADDELL, consulting engineer, New York City, for the design and supervision of construction of bridges in Missouri, Kansas, Oklahoma, Arkansas, and Colorado. Under the arrangement Dr. Waddell will make the economic studies, estimates and layouts, and will prepare the complete drawings and specifications for such bridge work as is undertaken and the Benham Engineering Co. will inspect and supervise construction for the client.

S. H. STIVERS, civil engineer, formerly of the Bureau of Valuation of the Interstate Commerce Commission supervising field appraisals and compilation of land valuation reports, announces his entry into private valuation practice in which he is prepared to give service in general valuation, recapture appraisals, commercial and industrial inventories, and tax cases. His offices are at 804-5 Mills Building, Washington, D. C.

ALFRED MULLIKIN has been made a member of the staff of William S. Lozier, civil and sanitary engineer, Rochester, N. Y., as engineer in charge of sanitary construction in the town of Brighton, N. Y. Mr. Mullikin was at one time an assistant sanitary engineer for New York State. He has made extensive investigations of municipal problems.

F. M. FAUDE, for seven years with the California Railroad Commission, the past two as chief hydraulic engineer, has resigned that post and joined the staff of the Chester H. Loveland Engineers, San Francisco.

GEORGE NORRIS, city engineer of Kelso, Wash., has resigned, and has been succeeded by C. M. THOMAS, who was formerly sewer and water engineer for the Long-Bell Lumber Co. in its development of the new lumbering city of Longview, Wash.

Rear-Admiral C. F. HUGHES, U. S. N., in charge of fleet training at the Navy Department, has been elected president of the American Society of Naval Engineers for 1925. He succeeds Capt. J. T. Tompkins, who has been president of the organization for the past two years.

HARTLEY ROWE, WALTER W. COOK and WILLIAM H. ROSE have been appointed directors of Lockwood, Greene & Co., engineers, Boston, Mass. Their appointment is effective as of Jan. 1.

Mr. Rowe continues as manager of the Boston office, Mr. Cook as manager of the company's architectural department with headquarters at Boston, and General Rose becomes a vice-president of the company with headquarters at Chicago. Mr. Rowe became associated with Lockwood, Greene & Co. in 1919, going to that firm from work with the United States Government, where he was in charge of building and design work in the Canal Zone. General Rose, who became associated with Lockwood, Greene & Co. after the war, resigned as manager of the New York branch of the organization in 1923 to become associated with the American Machine & Foundry Co. Soon after that, however, he rejoined the staff of Lockwood, Greene & Co.

Obituary

WILLARD KENT, consulting engineer, Narragansett Pier, R. I., who was secretary of the New England Water Works Association from 1899 to 1920, died recently, aged 73 years. Mr. Kent's early connection was with municipal and mill work, with general engineering, and with railroad surveys and water-works construction. In 1872 he became associated with Clemens Herschel on hydraulic work. Entering private practice in 1884, Mr. Kent designed and constructed water-works systems at Narragansett Pier, R. I., and Crete, Neb. He was designing and construction engineer on the Woonsocket, Columbian & Providence and the Burrillville electric railroads, and engineer of the "ray system" of electric railroads and of the Woonsocket Electric Machine & Power Co. In hydraulic work he was master in charge of apportionment of water power of Blackstone River at Woonsocket. For years he was manager of the Wakefield Water Co., which supplied water to Wakefield, Narragansett Pier, Peace Dale and Rock Brook. Upon ceasing to be secretary of the New England Water Works Association he was made an honorary member of the association.

A. C. SMITH, former chief surveyor of the Denver & Rio Grande R.R., died Dec. 29, 1924, aged 82 years. Mr. Smith was born at Bristol, England, and was a graduate of the Bristol School of Mines. He arrived in Colorado in 1870 and mapped out a great part of the road bed for the railroad.

ERNEST DRINKWATER, formerly town engineer of the city of St. Lambert, near Montreal, and city engineer of Montreal, South, and recently consulting engineer in Montreal, was found dead on the evening of Dec. 30, 1924, in the garage at his home in Montreal, a victim of carbon monoxide poisoning; he was 55 years old. A native of Manchester, England, and a graduate in civil engineering at a technical school there, Mr. Drinkwater went to Canada twenty years ago. For some years he was engaged on construction for the Montreal Street Railway Co. In the city of Westmount he was superintendent of construction and chief inspector of works, chiefly sewers; in Montreal, South, he was city engineer for four years; in 1920 he went to St. Lambert and two years later opened his consulting office in Montreal. He was identified with municipal construction of many kinds and also with city planning; his consulting practice was concerned with municipal engineering and public works.

PROF. CHARLES F. CAMERON, of the faculty of engineering and architecture of the University of Manitoba, Winnipeg, died on Jan. 18 after a long illness at the age of thirty-five years. He had been a member of the staff since 1919.

IRWIN C. CROMACK, who resigned from the position of assistant chief engineer of the city of Boston a year ago, died Jan. 20 of pneumonia. Mr. Cromack was born in Charleston, Mass., in 1852, and went to work for the city of Boston when 18 years of age as rodman. For 50 years he was employed by the city, passing through many grades of the engineering department before being appointed assistant chief engineer. He was a member of the Boston Map Co. organized in 1860, to compile plans of Boston. He took a leading part in the work of the Board of Survey, which had to do with the system of streets, both in planning and later constructing. Since his retirement from activity at the city hall, Mr. Cromack had been employed by the commission to draw up the city's ward lines.

SIR WILLIAM GARSTIN, who from the early 1870's to 1908 was connected with the public works departments of India and Egypt, and under whose direction Egypt was converted from basin to perennial irrigation by the construction of the Asyut weir, the Aswan dam and several barrages, died in London on Jan. 8 aged 75 years. He was born in India, educated at Cheltenham College and King's College, London. At the age of 23, according to London *Engineering*, he joined the Indian Public Works Department, with which he was connected until 1892, although in 1885 he went to Egypt and took up his long period of work on Nile irrigation. In 1892 he became inspector-general of irrigation in Egypt. Subsequently he was under-secretary of state for Egypt, and then advisor to the Egyptian Ministry of Public Works. On resigning the latter post, in 1904 he became a director of the Suez Canal, representing the British government. In 1905 the Egyptian government awarded him a grant of £15,000 in appreciation of his services. During the European war he "took a large part in Red Cross work and in 1918 he was created G. B. E.," states *Engineering*, which adds that "he showed great political, administrative and financial abilities, and was associated with many of the leading learned societies."

ARTHUR D. PRINCE, senior assistant division engineer of the Board of Transportation, New York City, died Jan. 21 of pneumonia, at his home in Glen Cove, Long Island. He was born in Glen Cove in 1870 and graduated as a civil engineer from Columbia University School of Mines in 1899. He was engaged in contracting work for a time and later joined the engineering staff of the Metropolitan Street Railway Co. Subsequently he went to the Department of Public Works and the Department of Street Improvements in New York City and was assistant engineer in charge of highway construction in the Bronx. In 1900 he became assistant engineer with the former Public Service Commission and he has been engaged in rapid-transit construction for twenty-five years.

SIR GUILFORD LINDSEY MOLESWORTH, former consulting engineer to the government of India, died Jan. 21 at his home in Bexley, Kent, England, at the age of 96 years. Sir Guilford was educated at King's School, Canterbury, and later at the College of Civil Engineers, Putney. He then served an apprenticeship under Sir William Fairbairn and a pupilage under the engineer-in-chief of the London & Northwestern Ry. Then he became chief assistant engineer of the London, Brighton & S. C. Ry. During the Crimean War he was located in the arsenal at Woolwich. In 1859 he went to India as mechanical engineer for the Ceylon Ry. and was subsequently its agent and chief engineer. From 1871 to 1889 he was consulting engineer to the government of India, and then returned to England. He was knighted in 1888 and was elected president of the Institution of Civil Engineers in 1904. He served during the Afghan War and received several decorations for his distinguished work. Sir Guilford was the author of "Pocket-Book of Engineering Formulas," of "Light Railways," "Gage of Railways in India," "Masonry Dams," and other treatises on technical subjects and many articles on economics and public affairs.

JOHN H. MADDEN, former valuation engineer of the Transit Commission of New York City, died Jan. 22 of heart disease in the Alston Sanitarium; his ailment was of long standing but became acute three weeks ago. Mr. Madden was fifty years of age, was born in New York City, was a graduate of the College of the City of New York in 1893 and four years later received the degree of civil engineering from Columbia University. His first professional work was under William Barclay Parsons, engineer of the first New York subway, and he worked on subway plans in 1897 and 1898. After a brief period as field assistant with the U. S. Geological Survey he again served under Mr. Parsons, then chief engineer of the Board of Rapid Transit Railroad Commissioners; he remained with this board and its successor, the Public Service Commission for the First District, from 1901 to 1918. As assistant engineer of the latter organization he had charge of the William St. subway. During the World War Mr. Madden helped build and operate the government's nitrate plants. With the organization of the New York City Transit Commission in 1921 he was chosen its valuation engineer.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

The Evolution of Highway Construction and Maintenance Equipment—I

By O. L. Kipp
Construction Engineer, Minnesota Highway Department, St. Paul

Paper, slightly condensed, presented at the annual meeting of the American Road Builders' Association, Jan. 5-9, Chicago. Part I, dealing with construction equipment, appears herewith; Part II, covering maintenance equipment, will be published next week.

Construction

IN practically all types of highway construction and maintenance equipment there has been during the past ten years a marked evolution, due to three major factors:

(1) Greatly increased volume of funds available for highway construction and maintenance.

(2) Increase in adaptation of gas engines and motor equipment to highway construction and maintenance.

(3) Radical economic changes, due to and following the war, which have contributed to the development of equipment.

Grading Equipment

LET us consider first the changes during ten years in grading equipment. Elevating graders, which had originally been developed in railroad work, were transferred to the highway construction field without modification. The standard layout consisted of eight head of horses or mules in front, driven by one man, and four head driven by another man from the "push." In many cases four additional head with a driver on a two-wheeled cart were added in front, and were commonly known as the gig team. Power was first substituted for stock by using gas or steam farm tractors on wheels, but these first efforts were not successful, as too much time was lost in turning and the tractors were not adapted to move over rough ground, nor on soft and slippery soil.

Crawler Tractors—Caterpillar tractors, first introduced about 10 years ago largely overcame these objections, but they did not displace stock to any marked extent prior to 1918. Since then, however, the substitution of caterpillar tractors for stock on elevating graders has been growing rapidly and the tractor runner is rapidly taking the place of the push and gig team drivers and the "high-up" driver who from his seat so dexterously managed his eight head of stock.

While there has been a large amount of experimental and pioneer work in the use of tractor-drawn wagons, trailers and carts, in conjunction with elevating graders, these have not yet displaced team-drawn wagons to any marked extent. As each year brings an increasing number and variety of mechanical substitutes for team-drawn wagons, however, the days of the familiar old-time grading skinner may be numbered.

Power Shovels—The adaptation of power shovels to highway construction has been rapid and successful. The early development of power shovels in railway construction, drainage, mining and industrial work did not produce a shovel entirely adapted to the average highway construction conditions. These conditions demanded greater mobility and greater flexibility. Greater mobility is now supplied by crawler or continuous-tread traction, not only on light revolving shovels but also on the heavy-duty railway types. This type of traction enables the shovels to move over rough and soft ground under their own power without blocking or leveling, and therefore with but little delay and expense.

While steam still maintains the leading position in shovel construction gasoline shovels are being developed rapidly, because of the advantage obtained by their use where coal costs are high or where feed water is difficult to obtain or when pipe lines are likely to freeze. Under such conditions the willingness of gasoline dealers to deliver gas to the shovel at tank wagon prices gives the gas shovel a material advantage. A further development in the displacement of steam for shovel power was accomplished when a small type shovel was recently equipped with a mechanical injection oil engine of the Diesel type, for which substantial economies are claimed.

Haulage—The use of the power shovel on highway construction has been greatly increased also by the development of hauling equipment suitable for use in conjunction with it. Formerly the horse-drawn wagon or car and track with horses or steam dinkeys were used for hauling the excavated material from the shovel. These are being displaced by motor trucks and gasoline industrial locomotives. Motor trucks are especially useful where a considerable percentage of the material must be hauled 1,500 ft. or more and where hauling conditions will permit of their use. Where hauling conditions are not favorable to the use of trucks and the quantity of excavation per mile is sufficiently large, car and track can be used to advantage, as on railroad work. If the haul is short or the output of the shovel is low, as in rock excavation, teams are still used to advantage as motive power on car and track work. With longer hauls and larger output the gas locomotive has taken the place of the steam dinkey once so common on railroad work.

Rock Excavation—In rock excavation on highway construction there has been a rapid and extensive development of portable air compressors and pneumatic drilling tools. Wherever rock excavation constitutes any considerable volume of the work hand drilling has given place to the pneumatic drill and portable compressor. This equipment has also displaced the use of steam with steam drills to a large extent in rock drilling on highway work. The tendency is toward greater mobility in the compressors and a wider range of sizes and greater individual air capacities.

In connection with rock excavation a wider variety of explosives has been made available as a result of the World War. However, the standard grades of dynamite and powder are still largely used. As a detonator the electric battery has been developed with a wide range of sizes adapted to use with the various sizes of drilling outfits. In addition to the electric battery the usefulness of Cordeau-Bickford as a detonator has been brought to the attention of grading contractors; this is a detonating safety fuse consisting of a lead tube filled with tri-nitrotoluene. The advantage of Cordeau-Bickford is derived from three important qualities: First, there is absolutely no danger in its handling or storage. Second, its average rate of speed is 17,500 ft. per second, and the rate of propagation and effectiveness does not diminish. Third, it increases the efficiency of the explosive charge.

Monthly Index Number for Locomotive Crane Sales

December sales of locomotive cranes by the seven member companies of the Locomotive Crane Manufacturers Association represented 28 per cent of the normal producing capacity of the plants reporting. This figure is the lowest for any month during 1924.

For the entire year of 1924 the association members worked on about 50 per cent capacity in locomotive cranes. The first half of the year was considerably better than the last half. All signs point to a considerably better year in 1925 than in 1924.

The accompanying table shows the sales index numbers for the past four months:

INDEX OF LOCOMOTIVE CRANE SALES

Month, 1924	Per Cent of Normal Capacity
September	29.0
October	28.5
November	40.0
December	28.0

Foregoing figures based on returns received from following manufacturers:

Brown Hoisting Mchy. Co.	Link-Belt Co.
Browning Co.	McMyler-Interstate Co.
Industrial Works	Ohio Loc. Crane Co.
	Orton & Steinbrenner

With all the developments in excavation methods and equipment it is worth noting that there are still conditions under which road grading can be performed most economically by station men and hand methods. This fact should not be entirely lost sight of by grading contractors in their enthusiasm for modern equipment and methods.

With the development of tractors the blade grader has grown in size and usefulness. In side borrow work it has displaced to some extent the elevating grader and the fresno wheeler and slip grader. Many attachments have been added, such as the back sloper and the scarifier which extend its range of service. The results obtained in finishing with a tractor and 12-ft. blade grader make this grader an almost indispensable part of a grading contractor's equipment, especially if the work is such that a caterpillar tractor can be used to advantage with other grading equipment on the job.

Fresnoes, wheelers and slip scrapers still have a place in highway grading, although for the most part they are used as auxiliary equipment on large projects, or alone on small jobs which would not warrant the use of larger equipment. Examination of the advertising sections of construction magazines shows an ambition on the part of manufacturers to motorize and enlarge the field of this type of equipment, but so far very little effect of such activity has been noticed around grading contractors' camps.

The inclusion of motor and tractor equipment in the highway grading contractor's layout has resulted frequently in such contractors providing themselves with mobile camps having greater comfort, convenience and sanitation. Tents and tar paper shacks so largely used have given place in many cases to cook-houses, dining rooms and bunk houses mounted on trucks so that they can be moved as required by tractors or trucks ordinarily employed in the outfit. These buildings are screened in summer and heated in cold weather.

Gravel Surfacing Equipment

THE past ten years have witnessed a material change in the character and extent of gravel surfacing equipment. Prior to the past decade labor and teams could be obtained at such low rates that such mechanical equipment as was available could hardly compete with the more simple method of hand shoveling, hand screening and team hauling. The first departure from this method came with the introduction of tractors and trailer wagons. These were used to some extent in competition with teams until about 1918 when the growing efficiency and number of motor trucks gave this type of hauling equipment an increased advantage. With the close of the war the trucks released to the states an excess war material, together with the increased output of truck manufacturers, made available such a large number of trucks that the prices bid for hauling by truck owners made them low bidders on practically all hauling work. Tractors and wagon trailers were unable to compete, and the high cost of men and teams placed them at a disadvantage. Within a period of a few years, therefore, here has been an almost complete transition from team and tractor haul for gravel surfacing to truck haul.

Trucks—The trucks first used were largely 4 and 5-ton units on solid rubber tires. They were generally overloaded from 50 to 100 per cent and consequently the hauling contractors suffered much loss and delay because the undeveloped country roads were unable to carry the loads. The results were not entirely satisfactory to the municipalities, as such heavy hauling damaged the subgrade of the road being gravelled as well as the side roads over which it was necessary to haul. The advent of smaller pneumatic-tired trucks was, therefore, welcomed and results obtained have enabled this type of truck to occupy almost exclusively the rural hauling field where pavements or frozen grades are not available.

Loaders—The development of hauling equipment from the team and wagon to the truck has been a large factor in the evolution of gravel-loading equipment. Another factor has been the increased cost of labor, while a third factor is found in the growing demand on the part of the highway departments for a uniformly graded material passing a ¾ to 1-in. screen. Where the gravel deposits contain 10 per cent or more of oversized material there is a growing demand that it shall be crushed and mixed with the gravel. On the other hand, where the deposits contain an excess of fine sand a sufficient amount of material passing a ¼-in. screen must be removed to bring the amount passing a ¾-in. screen above 25 per cent.

The evolution of gravel loading equipment has, therefore, been governed first by economy of loading trucks from local pits of varying size and under varying conditions; and, second, by the necessity of producing a uniformly graded material. The wide variety of gravel deposits encountered has led to almost as wide a variety of equipment being used. In some sections the natural grading of the material so nearly conforms to requirements that the small amount of oversize can be satisfactorily removed by dropping the material through a grizzly. Under such circumstances power shovels, cranes and elevating loaders have been used with an A-frame or other type of grizzly, without a storage bin. Belt or bucket conveyors loaded by teams through a trap are also frequently used in conjunction with a suitable screen and a small storage bin. In general storage bins, where used, are becoming smaller and more portable and greater reliance is placed on the efficiency of the loading equipment in reducing loading delays to a minimum.

Where gravel deposits contain a considerable amount of oversize a more efficient screening arrangement is necessary and the material is generally elevated by belt conveyors, draglines or other means to shaper or rotary screens mounted on portable bins. Where a larger amount of oversize exists in the deposit the state highway departments generally require that the oversize material be crushed and mixed with the gravel. Many combinations and arrangements of conveying equipment, screens and crushers have been devised by individual contractors. Perhaps the most complete machine for this purpose on the market is that manufactured by a Minneapolis concern; it comprises a dragline for digging material from the pit and conveying it to a belt conveyor which in turn carries it to the screens. The oversize from the screens is carried to the crusher from which the material is again carried to the screen. The material passing the screen is carried to a small bin of but a few yards capacity designed to hold the output of the plant during the interval ordinarily occurring between trucks. From this storage bin the material is carried to the truck by a large capacity belt conveyor which will load a truck in a few minutes. Power is furnished by gasoline engine and the whole outfit is mounted on wheels so that it can be readily drawn by a truck or tractor.

The evolution which is taking place in the spreading and compacting of the gravel surface is as much a matter of method as of equipment. Ten to fifteen years ago there were two types of gravel surface construction: One, following in a general way a waterbound macadam specification; the other, employed largely on township work, consisted merely of dumping a row of pit-run gravel along the side of the road and leaving it thus with little if any effort toward securing a uniform surface.

Our present method of spreading and compacting requires less equipment than the macadam method. The first requirement now is a smooth compacted subgrade with little if any crown. This is most successfully obtained ordinarily by maintenance with heavy equipment such as a tractor and 12-ft. blade, or large planer. The uniformly graded gravel is dumped from the trucks upon this subgrade as evenly as possible. It is then spread with a blade grader and all but approximately an inch of the material is shoved into windrows along each edge of the subgrade. On the 30-ft. subgrade ample width is available between the windrows for traffic. The thin layer of gravel in the center of the road is maintained by the maintenance patrolman with his regular maintenance equipment. The traffic is depended upon to compact this thin layer and as fast as this result is obtained additional material is brought from the shoulder windrows until all the material has been compacted. Where there is any tendency to develop waves or any other irregularities in the surface a tractor and heavy blade with scarifier attachment, if necessary, is used to correct the defects.

Paving Equipment

PRIOR to the past decade paving equipment had been developed largely to meet city conditions. With the extensive rural paving programs of the past decade there has come a comprehensive development in equipment which has effected practically every operation in pavement construction from the preparation of the subgrade to the curing of the pavement.

Fine grading of the subgrade was once largely a matter of men with picks and shovels. Now this hand work is supplemented by small tractors with scarifier and blade or by a subgrading machine riding on the forms and cutting exactly to the desired crown. The soil conditions encountered govern largely the method and equipment best suited to this work, but the man with pick and shovel is no longer left to worry the job out unaided. Accuracy in the finish of the subgrade is insured by checking with a templet of the specified section supported at its ends by the forms.

Forms—The side forms are now required to furnish not only more accurate alignment and grade to the finished pavement, but they are also called upon to guide the subgrader and to withstand the weight and movement of a finishing machine. These added requirements have resulted in the development of more rigid and adequately supported forms. Recent changes in pavement slab design have also added to this rigidity by placing the thickest part of the pavement slab at the outside edge instead of at the center, thereby increasing the height of the form from 6 or 7 in. to 8 or 9 in.

While the operation of form setting is still largely hand work a machine known as a form grader has recently been developed for grading according to the depth required for the form.

Proportioning — Perhaps the most far-reaching development has come in the method of handling and proportioning the fine and coarse aggregate. It is not many years since common practice allowed these materials to be dumped on the subgrade from carts, wagons or trucks, with more or less mixing of subgrade with the aggregate, and intermingling of the fine and coarse aggregate. With these materials dumped on the subgrade the time-honored method was to shovel from the subgrade into wheelbarrows and wheel the material to the mixer skip, depending on the laborers to load the wheelbarrows uniformly to the proper amount, and to get the correct number of wheelbarrow loads of each material in the batch.

With the increased cost of labor during the war there was introduced a belt conveyor with measuring boxes to eliminate the wheelbarrows. In some cases also a loader was introduced to pick up the coarse aggregate and reduce the number of shovelers required. Development along this line came to an end as the engineers in charge felt the need of methods more certain to insure in the concrete clean aggregate, more accurately proportioned. Specifications were drawn, therefore, to prohibit placing concrete materials on the subgrade; with this change began the development of proportioning plants. Until the last few years equipment for measuring fine and coarse aggregate has been largely devised by the contractor; more recently manufacturers have developed measuring devices which have tended to standardize methods of measuring by volume. Hardly had this advance in accuracy been made before it dawned on engineers that sand is subject to a wide variation in volume according to its moisture content and according to the conditions under which it is placed in the measuring box. This realization has lead to provisions for adjustment in the capacity of the sand-measuring box to compensate for the swelling of the sand due to its moisture content. As a further step towards accuracy in proportioning concrete paving materials at least one state highway department has abandoned volume measurement of such aggregate and had adopted a method of proportioning by weight.

Mixers—With the elimination of material from the subgrade and the development of proportioning plants, considerable development has resulted in concrete paving mixers. The use of a central mixing plant instead of a so-called paving mixer on the subgrade has consisted merely in designing a proportioning plant to discharge directly into an ordinary building mixer, mounted high enough to discharge into trucks. It does not appear that any definite type of central mixing plant layout has been developed, as nearly every contractor using this method has designed his layout according to his own ingenuity and the conditions surrounding his set-up. The use of the central mixing plant was made practical by the evolution which has taken place with regard to concrete consistency and the discovery that concrete of the desired consistency could be hauled almost any required distance without separation of its aggregates, or any injurious effects to the concrete.

In paving mixers there has been a very marked evolution. First, greater portability has been secured by substituting continuous traction for the old type of wheel traction. Second, suitable gas engines have been developed to such efficiency that they are practically as reliable as steam power for mixers. Third, power hoists have been developed for transferring batch boxes from industrial cars and dumping them into the skip or directly into the mixer.

Fourth, timing devices have been developed to regulate automatically the length of time the batch remains in the mixing drum. Fifth, means have been provided for more accurately gaging the amount of water added to each batch.

Materials Transport—In the matter of transporting materials to the paving mixer there have been two general methods in use, namely, industrial haulage over portable tracks and haulage over the subgrade with wagons or motor trucks. The industrial haul method used by Wayne County, Mich., early in the paving program remains practically unchanged as to method. The principal changes in this connection consist in the number of industrial locomotives available and their mechanical improvement. As compared with industrial haul there has been a greater change in the methods of hauling over the subgrade. Teams gave way to motor trucks and these have changed largely from heavy trucks on solid tires to lighter trucks on pneumatic tires. Various types of dump bodies have been developed but no particular type predominates.

With the use of trucks, turn-tables for turning trucks on the subgrade have been developed and at least one truck is on the market which has the same gear ratio both forward and backward and which can be driven backward as well as forward, thus eliminating the necessity of turning the truck on the subgrade.

Where the subgrade is soft a large portion of the objection to truck haul has been removed on many contracts by providing plank runways for the last 50 to 100 ft. adjacent to the mixer. The use of these runways insures a satisfactory subgrade. This protection for the subgrade is especially necessary where truck haul is used with a central mixing plant.

Finishing Machines — The development of finishing machines and equipment has made it possible to finish concrete of stiffer consistency, which results in greater strength. In general the finishing machines used have been of two types. One method, termed the Vibrolithic, requires a hand strike off of the concrete after which a tamping or vibrating action is secured by the vibration of an off-center motor cycle engine resting on a wooden mat about 2 ft. wide by 8 ft. in length. Following the tamping by this method the finishing is completed by belting in the usual manner. The second and more usual method of machine-finishing is with a machine consisting of a strikeoff templet followed by a tamping bar and a mechanically operated belt, all mounted on a framework riding on wheels along the tops of the forms.

In order to be certain of securing a satisfactory riding surface the pavement must be tested for uniformity of surface with a straight edge not less than 10 ft. in length. Ridges and depressions discovered by this means must be worked out and the whole surface given a final belting before the initial set of the concrete takes place. A large proportion of the surface irregularities ordinarily left by a finishing machine can be removed by pulling a wooden float 10 to 12 ft. in length transversely back and forth across the pavement.

Hand finishing is still used on many contracts almost entirely, and to some extent on every contract where there are sections of irregular width. The most common development of hand finishing methods requires first that the concrete be struck off and tamped by a strikeoff templet, second, that the surface be rolled with a light hand roller or floated with a transverse float, and third that the finishing be completed by a final belting just before the initial set.

Curing—There has recently been developed a new method of pavement curing with calcium chloride. This method eliminates the necessity of pumping water for curing and maintaining a pipe line back of the mixer. Where the central mixing method has been used in conjunction with calcium chloride curing it has been found possible to eliminate the pipe line and pump entirely.

(To Be Concluded)

Highway Equipment Exhibitors Elect Officers

New officers of the Highway Industries Exhibitors Association were elected at the annual meeting of the organization held in Chicago Jan. 7, during the week of the Good Roads Show. C. R. Ege, manager of the highways bureau of the Portland Cement Association, Chicago, was chosen as president. The other new officers are: C. F. Messinger, Chain-Belt Co., Milwaukee, vice-president; Fred G. Hudson, Western manager, *Engineering News-Record*, secretary (re-elected); H. S. Greene, vice-president, Barber-Greene Co., Aurora, Ill., treasurer.

The newly elected directors are: P. L. Griffiths, American Tar Products Co.; Chester Lehman, Blaw-Knox Co.; S. M. Williams, Autocar Sales & Service Co.; C. V. R. Fullenwider, Philip Carey Co.

After a discussion in which invitations from both San Francisco and Indianapolis were considered, the association voted in favor of Chicago as the place for holding the 1926 Good Roads Show.

Business Notes

McCLINTIC-MARSHALL Co., Pittsburgh, Pa., has recently acquired the Kenwood Bridge Co. and the Morava Construction Co., both manufacturers of structural steel, with home offices in Chicago.

MASSEY CONCRETE PRODUCTS CORPORATION has appointed W. Lyle McDaniel resident manager of its newly established district including Ohio, Indiana, Kentucky, West Virginia and part of Pennsylvania. His headquarters will be in Room 528 Dixie Terminal Bldg., Cincinnati, Ohio.

R. B. RANDALL, who for approximately six years was Western sales manager of the Blaw-Knox Co., has been appointed Western sales manager of the G. H. Williams Co., Erie, Pa., manufacturer of clamshell buckets, with headquarters in Chicago.

EDWIN JAMES ARMSTRONG, chief engineer, Erie Steam Shovel Co., Erie, Pa., died Jan. 21, at Savannah, Ga., where he went recently to regain his health which had been failing for several years. He was born May 12, 1861, at Hornby, N. Y., and began work in the machine shop of A. Weston & Co., Painted Post, N. Y., where he remained nine years, having served as apprentice, foreman and superintendent. A brief association with the Straight Line Engine Co. in 1888-89 preceded a connection with A. Robb & Sons of Amherst, Nova Scotia, builders of saw-mill machinery and high-speed steam engines for operating small electric light stations. Mr. Armstrong's next connection was with the Ames Iron Works, Oswego, N. Y. He left in 1900 to become chief engineer of the Ball Engine Co., now the Erie Steam Shovel Co.

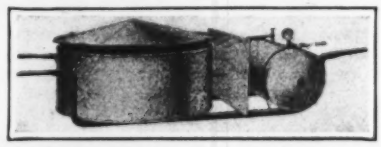
Equipment and Materials

Portable Kerosene Heater for Winter Construction Work

For winter construction work, particularly the erection of buildings, a portable heater, using kerosene as fuel and designed to eliminate some of the disadvantages in the form of smoke, soot and fumes of the ordinary salamander, has been developed by the Reynolds Portable Furnace Co., Louisville, Ky., as the result of experience gained with heating equipment for curing tobacco.

The device, weighing 183 lb. and carried on a frame mounted on wheels for easy movement around the job, operates on the general principle of a large blow torch. The overall dimensions of the furnace are: Length, 6 ft. 6 in., width, 3 ft. 2 in., height, 20 in.; when turned sideways, it may be passed through openings 2 ft. wide. The furnace shell is a steel and galvanized iron cylinder 38 in. in diameter housing a burner nozzle, jet chamber, generating coil of pipe, and baffle plate.

The furnace is started by heating the generating coil and baffle plate for a few minutes with an oil-saturated



rag. Kerosene from a 20-gal. fuel tank is then turned slowly into the coil and generation starts immediately, without smoke, almost at maximum heat. The liquid fuel is converted into a gas which comes out of the burner nozzle, strikes the baffle plate and is spread into a saucer shaped fan, producing a flow of heated air claimed by the manufacturer to be equal to that of an ordinary hot-air furnace in a ten-room dwelling.

In addition to producing comfortable working conditions on winter construction, the furnace has an advantage in plastering or painting operations in that is does not smoke or soot white walls or ceilings. Another advantage, it is pointed out, is a close control of the amount of heat and the ability to shut off the furnace and conserve fuel when the equipment is not needed. The device has been applied successfully to the winter work of a number of Louisville contractors.

Machine Lays Burlap Cover Over New Concrete Roads

For covering newly constructed concrete roads with a burlap blanket during the curing period a machine has been placed on the market by J. Lintz & Son, Fort Branch, Ind. The device, known as the Feigel covering machine, consists of a latticed steel framework or bridge supported at either end by a pair of flanged wheels running on the tops of the road forms, and carrying a spindle or roller of 4-in. pipe around which a long strip of burlap covering is wound or unwound. To prevent the wind blowing or moving the burlap about while winding or unwinding, there is a second pipe bar to hold the blanket down.

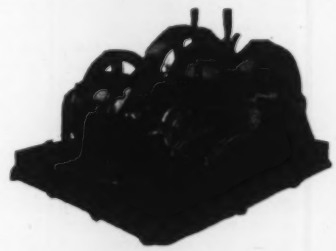
The machine weighs 1,000 lb. and consists of only seven parts, which are

shipped knocked down and assembled on the job. The machine is made to travel along the forms by means of a sprocket and chain drive operated by a crank. With this machine, the manufacturer points out, the blanket is laid on and not dragged over the pavement, thus preventing damage to the green concrete.

Single-Drum Hoist for Tunnel, Quarry and Mine Service

For service in tunnels, quarries and mines, the Thomas Elevator Co., Chicago, has placed on the market new single-drum double reduction hoists, electrically operated and equipped with band frictions of the flat type. The machines are built in sizes of from 25 to 150 hp. with drum diameters from 20 to 48 in. Hoisting duties of the various models range from 3,000 lb. on a single line at a speed of 215 ft. per minute to 9,000 lb. at 450 ft. per minute.

The brake is located on the opposite end of the drum from the friction, so



that any heat generated by slipping the brake while lowering a load cannot affect the friction. Motor equipment may be provided either for direct or alternating current.

Building Shores — H. W. ROOS Co., Cincinnati, Ohio, has published in an illustrated pamphlet the results of tests of its adjustable building shores, known as Rooshors, by the testing laboratory of the University of Pennsylvania. As the result of these tests, the Bureau of Building Inspection, Philadelpha, has approved the use of the shores, based on a safe working load of 3,000 lb. per shore.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Favorable Outlook For 1925 Construction In Canada

An examination of contract figures, proposals, building permits, etc., shows the 1925 outlook for Canadian construction to be more favorable than otherwise.

Contracts published in *Engineering News-Record* at a minimum of $15,000 for water-work and excavations, $25,000 for other public works, $40,000 for industrial and $150,000 for commercial buildings, show that 1924 was only 0.2 per cent below the preceding year.

The 1924 total for Canada was $102,923,000 with that of 1923, $103,175,000, at the minimum mentioned in each case. From Jan. 1 to 15 the weekly totals show a consistent gain in money value of contracts let for the entire Dominion.

During the months of December, January and February, Canadian construction is at low ebb. Activity in contract letting at this time is significant of increased volume in February and March, at which time work of large dimension is usually tendered.

Excavating work in Canada starts in April and May, as a rule, with the height of the construction season coming in the months of June, July and August.

Actual construction on large jobs terminates in November; activities, after that, being confined mostly to inside work with view to completion in time for occupancy in May.

Since Dec. 1, 1924, *Engineering News-Record* has published announcements of proposals, awards, etc., on six large pulp and paper mills, either in Canada or in the U. S. near the border, for Canadian concerns. In no case has any one of these projects been under a million dollars in value.

The Fraser Companies of Edmunton, N. B., soon take bids on a $1,000,000 paper mill to be erected at Madawaska, Me.

The International Paper Co. of New York, awarded the contract for a $1,000,000 paper plant at Three Rivers, Que., to the Fraser-Brace Co. of Montreal.

The St. Lawrence Paper Co., Ltd., plans an extension to its plant at Three Rivers, Que., amounting to $3,000,000.

The contract for a pulp and paper mill for Price Bros. of Quebec, to be erected at St. Joseph D'Alma, Que., was awarded to W. I. Bishop, Ltd., of Montreal and the Dominion Bridge Co., Ltd., of Lachine. Architects estimate, $2,000,000.

The Great Lakes Paper Co. is having plans prepared for a plant at Ft. William, Ont., to cost $1,500,000.

The Quebec Pulp and Paper Co., Ltd., of Quebec, is having plans prepared for a plant at Sillery, Que., to cost $10,000,000.

These six mills represent a combined money value of $19,000,000, with a total daily capacity of 2,533 tons.

In money value of building permits issued during 1924, British Columbia very nearly equaled the combined total of all the other provinces, not including Ontario and Quebec. In the two last mentioned, permits were issued, amounting to $77,813,000 and $73,508,000, respectively.

Large projects such as the university group at Point Grey, the power development at Stave River and a pulp plant at Powell River, aggregating several millions, were not included in the totals, as no building permits were necessary.

Plans for the construction at Vancouver, B. C., of an addition to the mammoth Hudson Bay retail store, to cost $2,500,000, were recently submitted to the City Board of Works.

Bond Sales in 1924 Heaviest on Record

The December total of state and municipal bond sales amounted to $86,314,807 for the entire country, according to the *Commercial and Financial Chronicle*. This compares with $113,645,909 for December, 1923 and $71,141,055 for November, 1924.

The yearly total established a record for the past thirty-three years, with new issues aggregating $1,366,745,579. The only year since 1892 to approach the one just closed was 1921, with a total of $1,208,548,274.

The four heaviest sales during December were: $9,000,000, New Jersey State 4½s at 101.375; $5,320,000, Los Angeles City School Dist. 5s at 102.87; $4,000,000, Illinois State 4s at 97.5575; $3,000,000, Philadelphia 4s at 102.29.

REPRESENTATIVE PUBLIC BOND SALES DURING DECEMBER, 1924

State	Purpose	Amount	Rate per Cent	Sold For	Basis	Dated	Maturity	Purchased By
Illinois	Highway	$4,000,000	4	97.55½	4.287	Jan. 1, 1925	1932—39	Geo. B. Gibbons & Co., New York
Porto Rico	Public improvement	3,000,000	5	107.165	4.56	July 1, 1923	1950—55	Hallgarten & Co. and others
County and Sub-Divisions								
Blount, Tenn.	Road bonds	380,000	5	102.51	.....	Jan. 1, 1925	1925—63	I. B. Tigrett & Co., Jackson
Butte Co. Reclamation Dist., Calif.	Reclamation	331,000	6	97.60	6.25	Jan. 11, 1923	1937—41	Dean, Witter & Co., San Francisco
Cameron Co. Road Dist., Tex.	Highway	80,000	5	100.26	4.99	Dec. 10, 1924	1957—60	N. C. Burt & Co., Houston
Essex, N. J.	Vocational school	1,095,000	4½	100.48	4.22	Jan. 2, 1925	1926—63	Fidelity Trust Co., Newark
Henry, O.	Roads	7,500	5	101.74	4.74	Jan. 2, 1925	1926—33	Detroit Trust Co., Detroit
		28,000	5	101.88	4.54	Jan. 2, 1925	1926—34	
Ideal Farms D.D., Fla.	Drainage	246,000	6	95	.....	Feb. 1, 1925	1925—50	Fred M. Crane Co.
Lyon, Minn.	Drainage	36,000	4½	101.30	.....	.....	.....	Minneapolis Trust Co., Minneapolis
Marshall, Ia.	Road	800,000	5	100.01	4.99	Dec. 1, 1924	1928—39	Ballard, Hassett & Beh, Des Moines
St. Joseph, Mich.	Road	23,000	5	101.04	4.79	Dec. 1, 1924	1926—34	Joel Stockark & Co., Detroit
Tippecanoe, Ind.	Highway	8,000	4½	101.31	4.23	Oct. 11, 1924	1926—35	J. F. Wild & Co., Indianapolis
		93,000	4½	101.32	4.23	Nov. 8, 1924	1926—35	
South San Joaquin Irr. Dist., Calif.	Irrigation improvements	50,000	5½	101.50	.....	.....	.....	Bayley Bros., Los Angeles
Brighton Sewer Dist. No. 2, Monroe Co., N. Y.	Storm sewer	192,000	4½	101.52	4.34	Jan. 1, 1925	1930—49	Geo B. Gibbons & Co., New York
Municipality								
Blairsville, Pa.	Water	125,000	4½	103.34	.....	Jan. 1, 1925	1937—54	Mellon Nat. Bank of Pittsburgh
Celina, Tex.	Water-works	40,000	5½	100	.....	Nov. 15, 1924	Serially	Garrett & Co., Dallas
Chicago, Ill.	Street improvement	3,500,000	4	97.81	4.29	Jan. 1, 1925	1927—44	Harris, Forbes & Co., and others
	Lighting	1,000,000	4	97.81	4.29	Jan. 1, 1925	1927—44	
	Bridge	350,000	4	97.81	4.29	July 1, 1924	1927—43	
Ft. Meyers, Fla.	Improvement	226,000	5½	104.09	4.71	Dec. 1, 1924	1925—34	J. G. White & Co., N. Y. C.
Johnson City, Tenn.	Paving	53,200	6	103	.....	Jan. 1, 1925	1926—45	Weil, Roth & Irving Co., Cincinnati
Lansing, Mich.	Bridge, Sewer, Paving	1,057,511	4½	100.71	4.327	Jan. 2, 1925	1926—41	Geo. B. Gibbons & Co., Inc., N. Y. C.
Mahanoy City, Pa.	Improvements	300,000	4½	100.375	4.45	.....	1925—54	E. H. Rollins & Sons, Philadelphia
Morganfield, Ky.	Water-works	120,000	5	100	.....	.....	.....	Caldwell & Co., Nashville
Raleigh, N. C.	Street improvement	1,000,000	4½	100.05	4.61	Jan. 1, 1925	1926—45	White, Weld & Co., and others of New York
	Water	350,000	4½	100.05	4.61	Jan. 1, 1925	1926—65	
Rochester, N. Y.	Subway	2,000,000	4½	101.644	4.07	Feb. 1, 1925	1926—55	Guaranty Co. of N. Y. and others
	Water-works	400,000	4½	101.644	4.07	Feb. 1, 1925	1926—55	
Salinas, Calif.	Municipal improvements	40,000	5	102.90	.....	.....	1926—45	Dean, Witter & Co., San Francisco
Seattle, Wash.	Municipal improvements	449,228	6	100	.....	.....	.....	.....
Shenandoah, Ia.	Municipal improvements	20,000	4½	100	.....	Nov. 1, 1924	1927—43	Shenandoah Nat'l Bank
	Streets	22,400	4½	100	.....	Nov. 1, 1924	1927—43	Geo. M. Bechtel & Co., Davenport
Spartanburg, S. C.	Water	1,350,000	4½	101.14	4.68	Jan. 1, 1925	1930—65	Caldwell & Co., Nashville
Wooster, O.	Street	7,500	5	100.06	4.99	Jan. 1, 1925	1926—35	Ryan, Bowman & Co., Toledo

Large Projects In Prospect

The following represent just a few of the big engineering construction jobs on which bids are asked or will soon be called for. Further details are given in the Construction News section of this issue, pp. 49 to 61.

Proposed Work

Paper mill, Sillery, Que., Quebec Pulp & Paper Co., Ltd., $10,000,000.

Electric lines, etc., Seattle, Wash., ordinance providing for bonds passed, $15,000,000.

Theaters, New York, N. Y., Bing & Bing, $4,000,000.

Highway, 30-mi., Buffalo, N. Y., making surveys, $4,000,000.

Bids Wanted On Big Jobs

Seamans' Church Institute, New York, N. Y., Warren & Wetmore, archts., $1,000,000.

Apartment, Houston, Tex., Brickley & Brickley, archts., $1,000,000.

Theater and office, Miami, Fla., J. Eberson, archt., $1,000,000.

Large Contracts Let During Week

Power plant, Conowingo, Md., to Stone & Webster, N. Y. C., $52,200,000.

Hotel, New York, N. Y., to Todd, Robertson, Todd Engr. Corp., $10,000,000.

Power plant, Trinidad, Tex., to Texas Constr. Co., Dallas, $3,000,000.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of January 1, the next on February 5.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb	$3.34	$3.90	$4.15	$3.10	$3.35	$3.07½	+$3.15	$3.35	$4.25
Structural rivets, 100 lb	4.25	4.45	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb	3.24	3.40	3.38	2.60@3.00	3.25	3.97½	3.35	3.25	4.00
Steel pipe, black, 3½ to 6 in. lap, discount	48%	54.2%	43%	56½%	54.25%	36%	44.7@55.5%	45%	59.49
Cast-iron pipe, 6 in. and over, ton	54.60@55.60	56.00	56.00	47.20@48.20	55.50	62.00	53.00	65.00	60.00
Concreting Material:									
Cement without bags, bbl	2.50@2.60	2.35	2.05	2.10	2.42	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd	2.25	1.90	2.38	3.00	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd	1.25	1.40	2.00	3.00	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.85	2.00	2.83	3.00	1.75	2.50	2.15	3.00	2.25
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	60.00	34.00	56.00	55.00	39.75	39.75	29.00	26.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	23.00	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.50@3.00	1.45	1.85	1.26	1.35	2.70	1.60	2.80	10.50
Common brick, delivered, 1,000	18.00	10.50	11.60	12.00	15.00	12.00	14.50	14.50	17.50
Hollow building tile, 4x12x12, per block	Not used	.1004	.0941	.06	.07	.085	.....	.11	.12
Hollow partition tile 4x12x12, per block	.1162	.1004	.0941	.06	.....	.085	.108	.11	.10
Linseed oil, raw, 5 bbl. lots, gal	1.18	1.26	1.30	1.25	+1.29	1.40	1.24	1.12	1.11
Common Labor:									
Common labor, union, hour	.75	.30	.....	.82½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.75	.50@.55	.35@.50	.50	.50	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 62½c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; lump finishing lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.60 for Kelly Island and Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand stone, gravel and lump lime per ton. Stone, lime and tile are delivered; sand, gravel and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.90). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Conditions Affecting the Market

Advances continue to hold the lead over the declines in prices of basic construction materials. The principal exception to this trend is found in the situation in the New York market. Here, building materials are not moving at a seasonal rate of speed, because of the strike of wire lathers' foremen.

New York City building permits for 1924 were 7 per cent greater than those for the year preceding. During the first half of the current month, there has been a slight slump compared with the corresponding period in 1923. Chicago permits gained in number rather than money value during the year just closed.

One of the best indicators of current business conditions is the weekly report of carloadings issued by the American Railway Association.

Loadings for the week ended Jan. 10, the latest figures available, amounted to 932,807 cars, the highest weekly total ever reached before at this season of the year.

All classes of revenue freight shared in the gain, particularly miscellaneous materials and merchandise in less-than-carload quantities.

This latter class represents the business done by small manufacturers and dealers and gives a fair idea of the greater volume transacted by the larger firms.

Structural steel sales for 1924 amounted to 2,280,900 tons as against 2,174,550, for the year preceding, a gain of 5 per cent. The steel demand has slackened during the past four weeks, but without any perceptible effect upon prices or production.

The lumber movement for the week ended Jan. 17, shows improvement over the preceding week in new business, shipments and output, according to latest reports of the National Lumber Manufacturers Association. In all except shipments the volume is considerably under that of a year ago.